

Evaluating an Urban Stream Restoration for Improving Bank Stability, In-Stream Habitat, and Water Quality

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Outline

- Purpose
- Partners
- Site Selection
- Selected Site Conditions
- Monitoring Results
- Conclusions



Purpose

Long Term Goal

Provide evaluation of tools to restore and protect aquatic systems and forecast the ecological, economic, and human health outcomes of alternative watershed management solutions

Short Term Goal

Short Term Goal: Monitoring and development of predictive relationships to evaluate receiving water improvements following urban stream restoration

Phase I • Stream bank and channel restoration

Phase II • Other targeted watershed enhancements



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Scientific Objective

Phase I (Shorter Term)

Develop from monitoring data predictive relationships to evaluate the effectiveness of stream bank and channel restoration for:

- Reducing bank cutting and sedimentation
- Protecting critical infrastructure and property
- Increasing available biological habitat

Phase II (Longer Term)

Monitor watershed enhancements to develop predictive relationships that assess the effectiveness of targeted watershed Improvements:

- Identify locations based on multiple benefits
- Management based on stressors of concern
- Demonstrate green technologies
- Improve water quality and eliminate stream impairment



Regulatory Objective

Phase I (Shorter Term)

- Reduce sediment inputs to the stream
- Protect critical infrastructure and property
- Improve macroinvertebrate indices scores

Phase II (Longer Term)

- Identify watershed improvement locations based on multiple benefits
- Manage watershed based on stressors of concern
- Demonstrate green technologies – including both structural and nonstructural practices
- Improve water quality and eliminate stream impairment
- Provide tools to MS4 communities that effectively reduce or eliminate stream impairment (achieve TMDL)



Project Desires

Locational Needs:

- A planned, designed, and funded stream restoration with a start date of Spring 2006
- Protection of a low-order stream
- Monitoring data of baseline conditions of the pre-installation health of the stream ecology
- Pre-installation data on stressors that impact stream ecology
- Within driving distance of Edison, NJ
- Location with safe, all-season access and some assurances of equipment security



Other Desirable Site Criteria

- The installation preferably has established performance expectations
- The receiving waterbody is within an MS4
- The receiving waterbody is 303(d) listed (may have TMDL in place or in development)
- A stream with USGS gauging station
- A watershed with a stream that is either moderately degraded or slightly degraded
- Planned post-BMP monitoring to evaluate the improvement and health of the stream



Possible Locations

Location candidates:

- TBD by NJDEP
- Lower Beaverdam Creek, MD
- Donaldson Run in Arlington County, VA
- Balston Beaver Pond, Arlington, VA
- Four Mile Run, VA
- **Accotink Creek, Fairfax, VA**



City of Fairfax Restoration Goals

- Restore the stream channel to a stable, self-maintaining condition and reduce stream bank erosion
- Improve low flow habitat conditions
- Improve index scores for macroinvertebrates
- Improve fish habitat and density
- Meet State WQS for fecal coliform/E.coli (2004) and aquatic life impairment (1998)

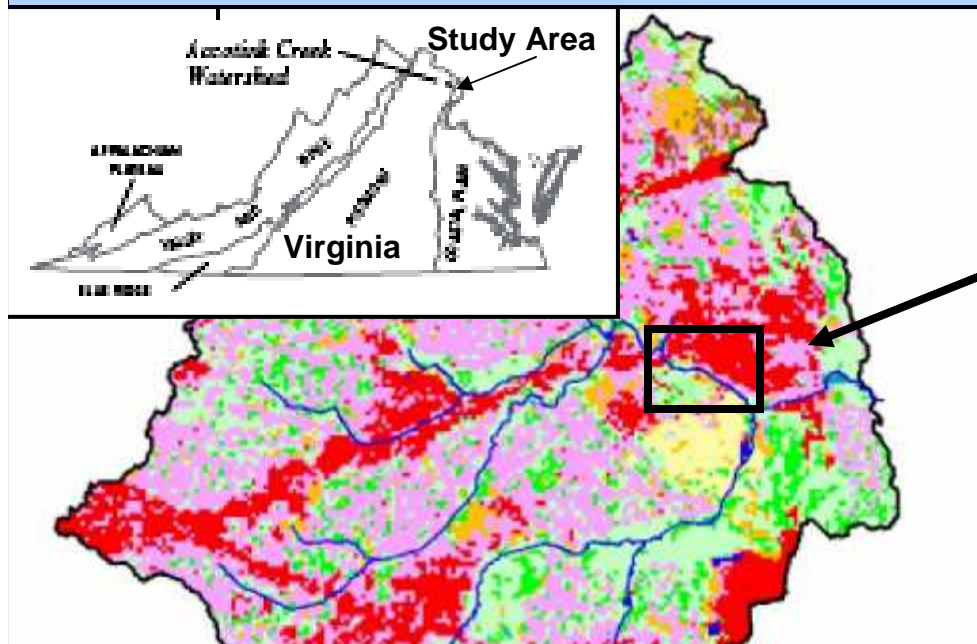


Project Partners

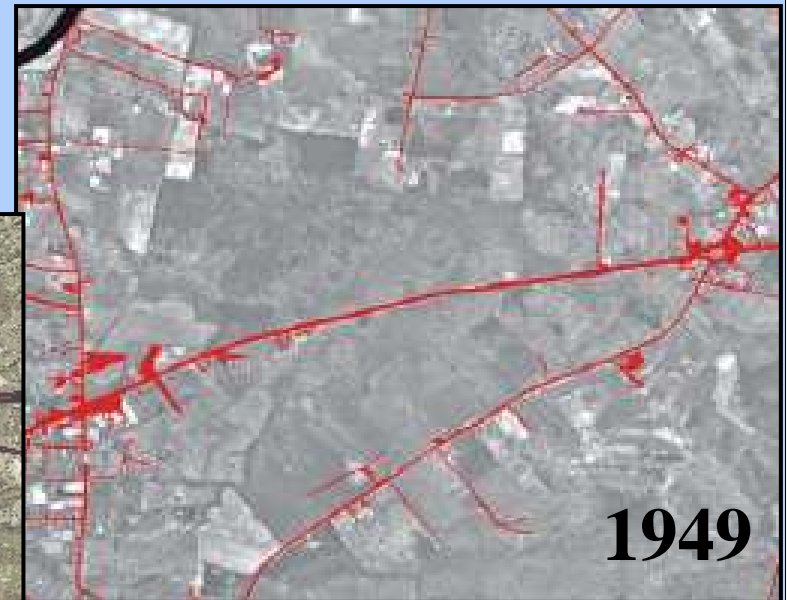
- U.S. EPA ORD - NRMRL
- U.S. EPA Region III
- City of Fairfax, Virginia
- Center for Watershed Protection (CWP)-
Cooperative Agreement with EPA Region III
- United States Geological Survey (USGS)
- Virginia Department of Environmental Quality (VADEQ)
- Northern Virginia Regional Council
- Virginia Department of Conservation and Recreation (VADCR)



Accotink Watershed Land Use

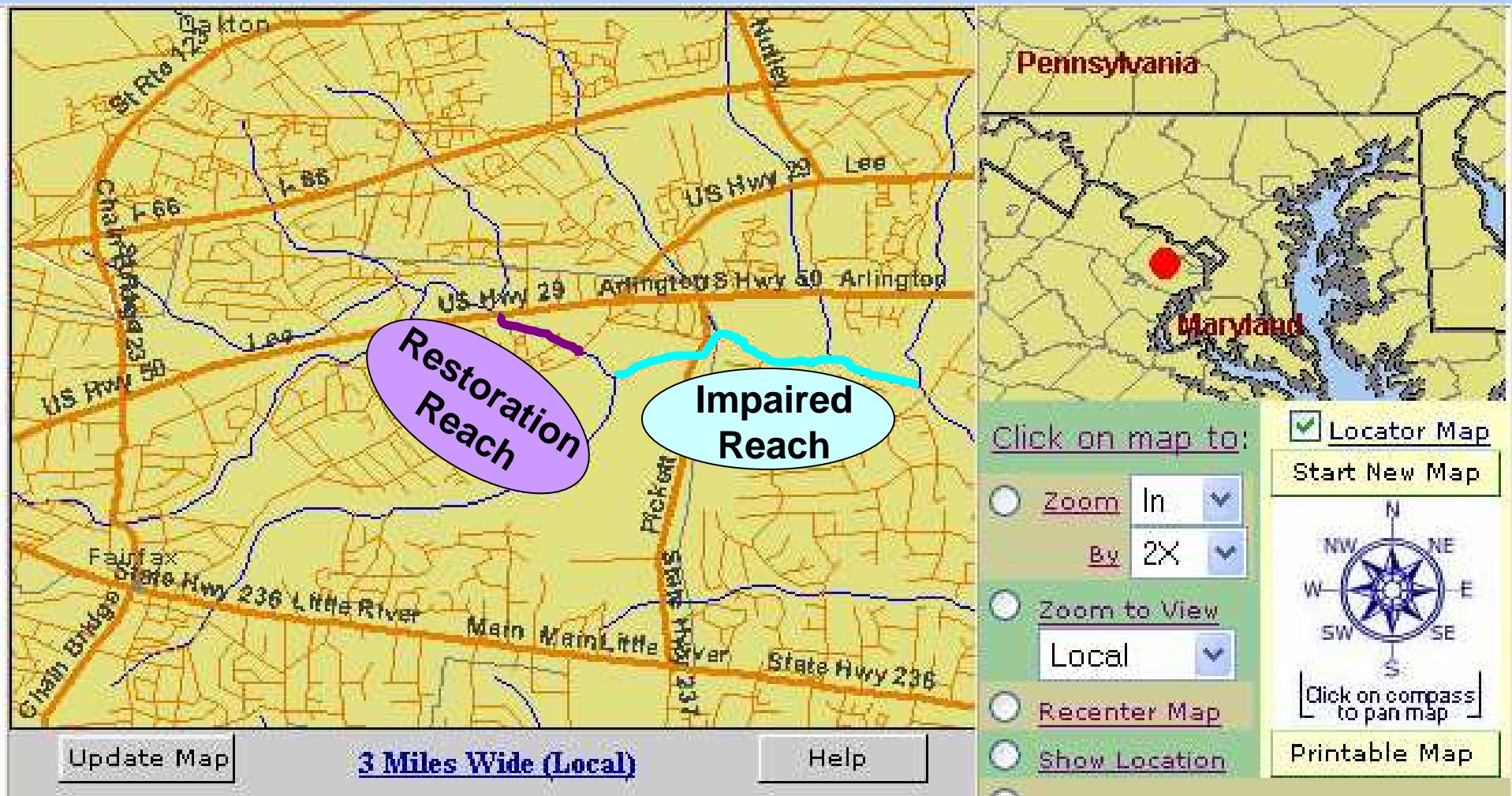


Area of
Interest for
Restoration



NT
Environmental decisions

303d Listed Impaired Waters



Water Quality Attainments

Designated Use Category	State Designated Use	Attainment Status	Threatened
Fish, Shellfish, and Wildlife Protection and Propagation	AQUATIC LIFE SUPPORT	NOT SUPPORTING	No
Recreation	PRIMARY CONTACT (RECR)	NOT SUPPORTING	No

2006 303(d) List Summary of Impaired Waters (Category 5) Needing TMDL Study* Potomac and Shenandoah River Basins

TMDL Watershed Name

TMDL Group ID	Use	Impairment	River (Miles)	Reservoir (Acres)	Estuary (Sq. Miles)	Initial List Date	TMDL Dev. Date
Accotink Creek							
00313	Aquatic Life	Total Size Benthic-Macroinvertebrate Bioassessments (Streams):	8.62			1998	2008
60150	Recreation	Total Size Escherichia coli:	1.19			2004	2014
01784	Recreation	Total Size Fecal Coliform:	8.62			2004	2016

Probable Sources Contributing to Impairment

State Source	EPA Source Classification
WATERFOWL	NATURAL
MUNICIPAL (URBANIZED HIGH DENSITY AREA)	URBAN-RELATED RUNOFF/STORMWATER
ILLICIT CONNECTIONS/HOOK-UPS TO STORM SEWERS	SPIILLS AND UNPERMITTED DISCHARGES



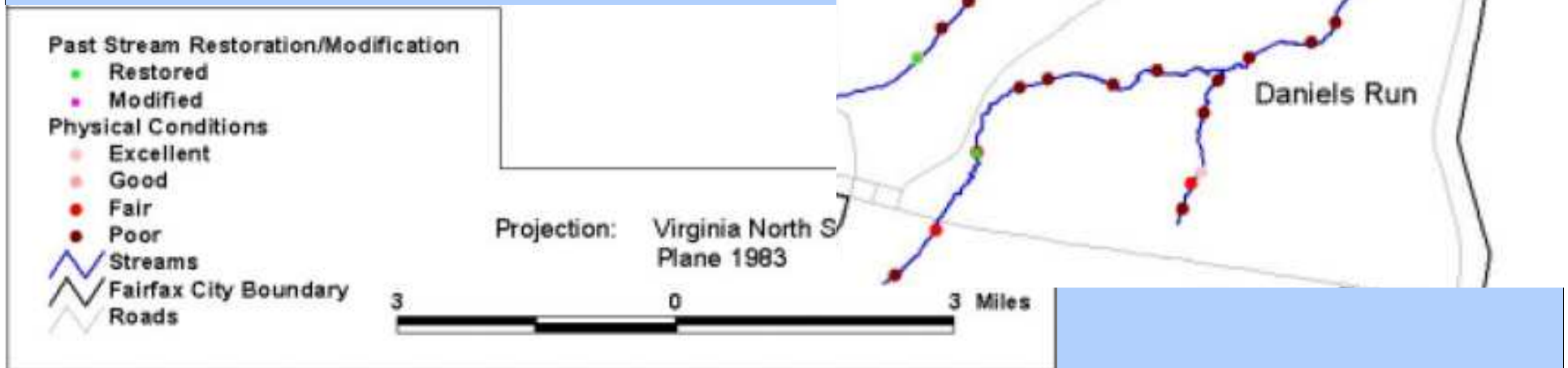
Pre-Restoration Conditions of the Watershed

- Physical Conditions
- Habitat and Biological Conditions
- Velocity vs. Stream Condition



Physical Conditions

- Channel Condition
- Hydrologic Alteration
- Riparian Zone Vegetation
- Vegetative Protection
- Bank Stability



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Habitat and Biological Characteristics of the Streams

- Sediment Deposition
- Water Appearance
- Nutrient Enrichment
- Barriers to Fish Movement
- In-Stream Fish Cover
- Pools
- Insect/Invertebrate Habitat
- Canopy Cover
- Riffle Embeddedness
- Macroinvertebrates Observed

Habitat and Biological Conditions

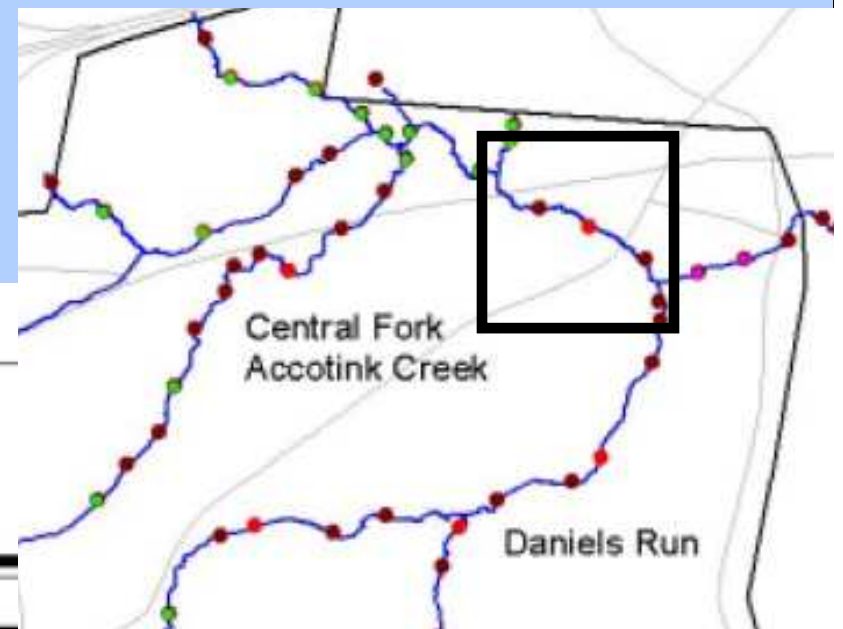
- Excellent
- Good
- Fair
- Poor

- Streams
- Fairfax City Boundary
- Roads

Projection: Virginia North State Plane 1983

3

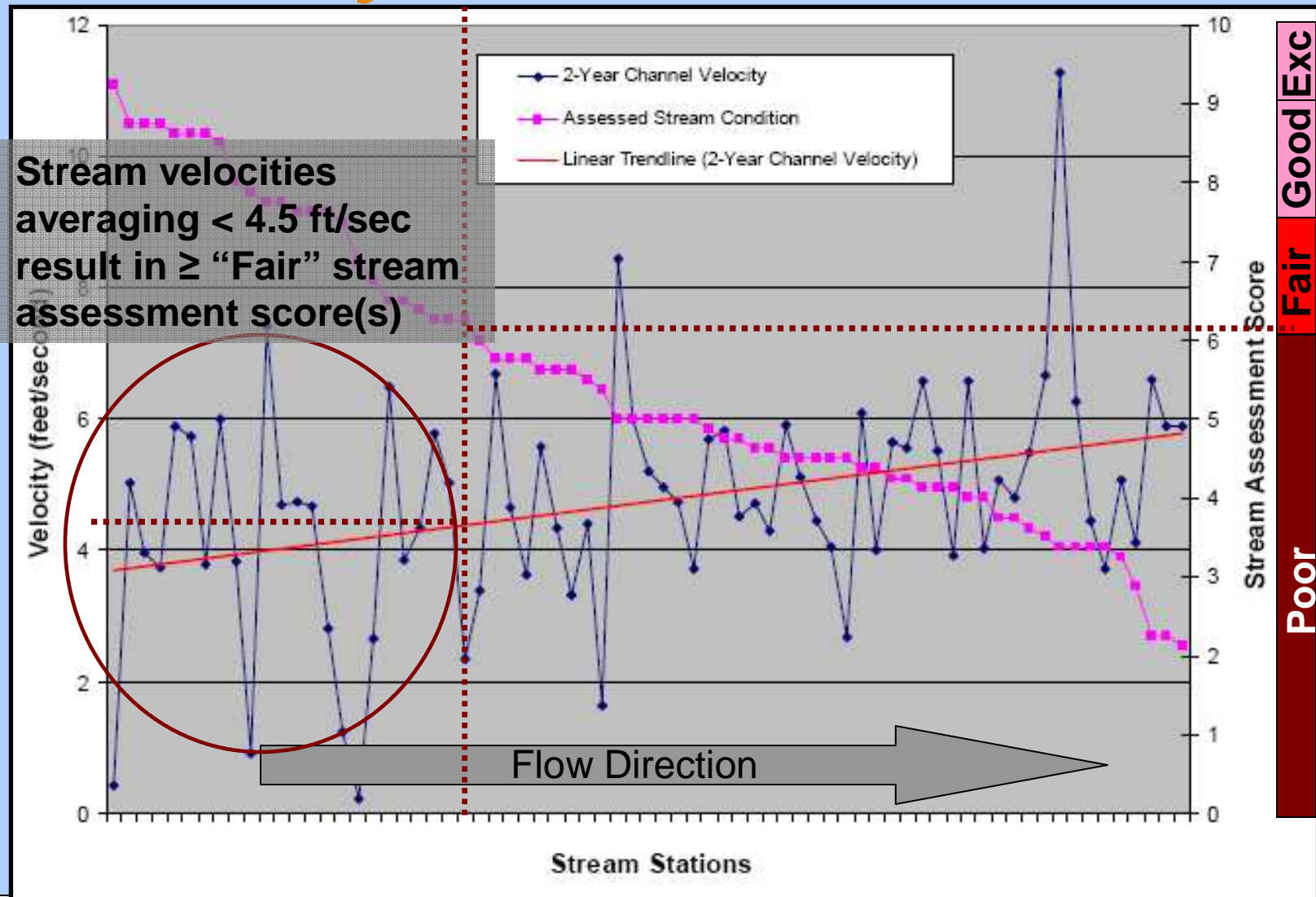
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Relationship Between Channel Velocity and Stream Condition



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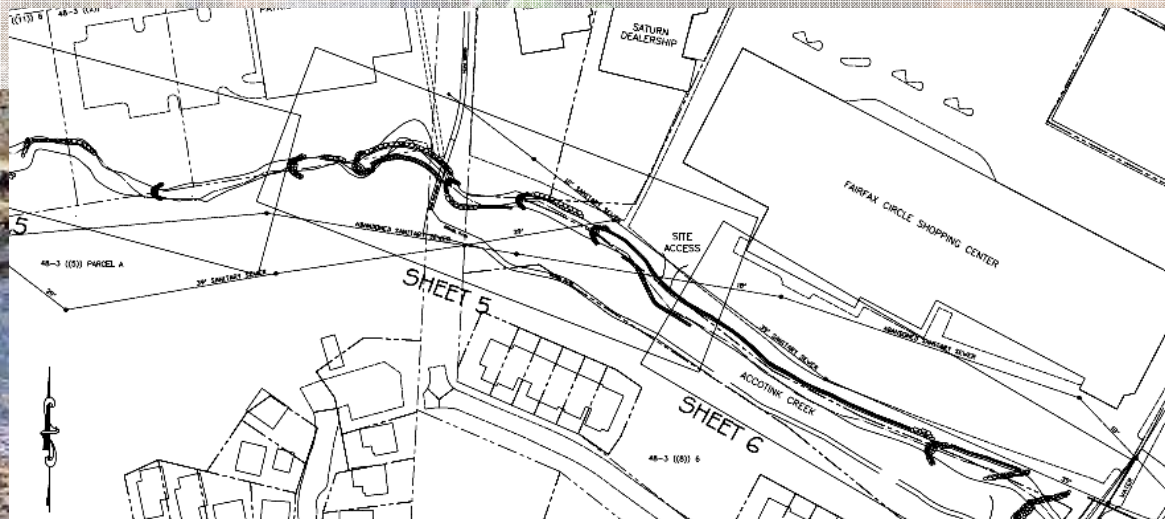
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Restoration of Accotink Creek, VA

Restore 1800 Linear Feet of Stream Channel

Tools:

- Imbricated rock wall
- Rock veins for slope reduction and pool formation
- Reduce slope of bank
- Widen stream channel (where possible)



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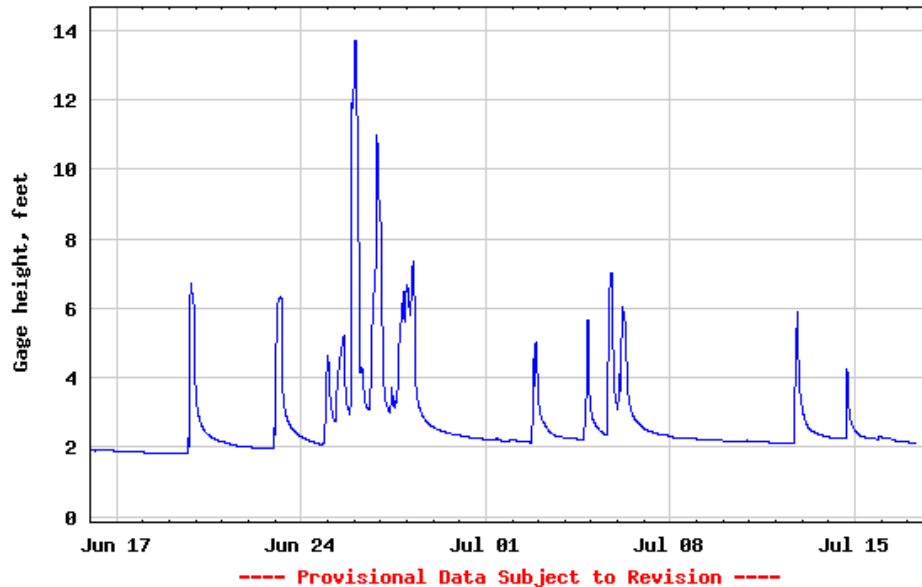
Restoration Completed

- Restoration Completed June 6th, 2006
- 3" rainfall in 2 hours on June 9th
- Post-Storm Walk through June 21st
- MAJOR Flooding June 23rd – 26th
(closed U.S. EPA Headquarters in D.C. for 5 days)

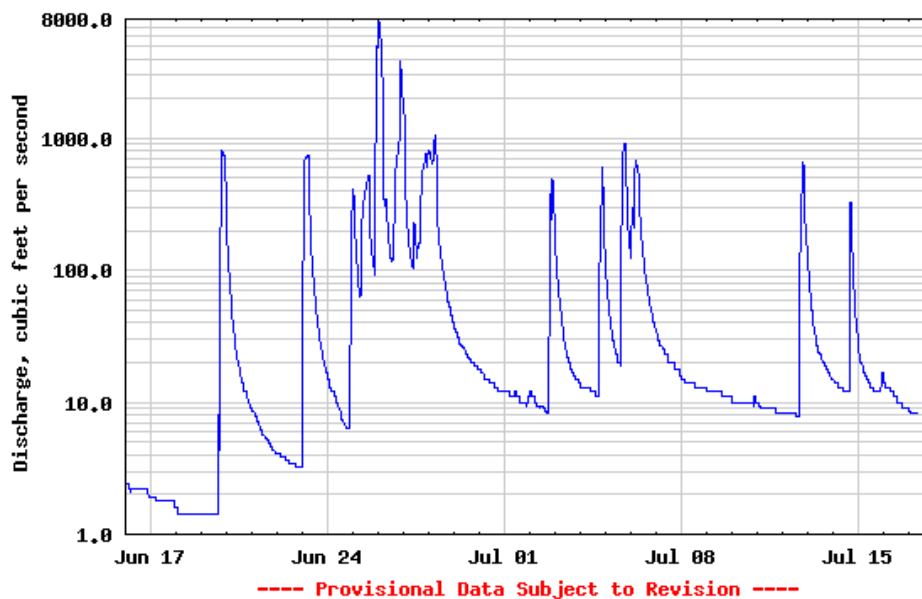




USGS 01654000 ACCOTINK CREEK NEAR ANNANDALE, VA



USGS 01654000 ACCOTINK CREEK NEAR ANNANDALE, VA



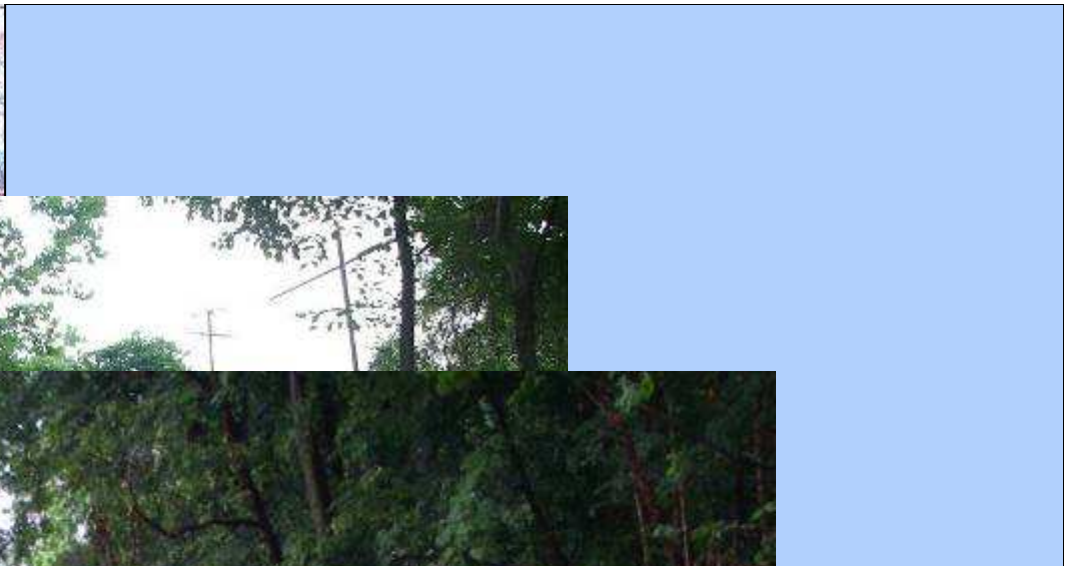
June 28, 2006

“In Fairfax County, Va., two streamflow gages recorded peaks near the 50-year recurrence interval and one streamflow gage recorded a peak near the 100-year recurrence interval.”

-USGS and NWS

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Monitoring of Restoration

- Continuous monitoring of WQ and flow using YSI-EDS's and AS velocity/depth probes
- WQ wet and dry weather discrete samples
- Quarterly biological sampling
 - Benthic macroinvertebrates
 - Vegetation cover
- Annual stream morphology sampling
 - Cross-sectional surveying
 - Longitudinal surveying
- Quarterly stream pebble counts



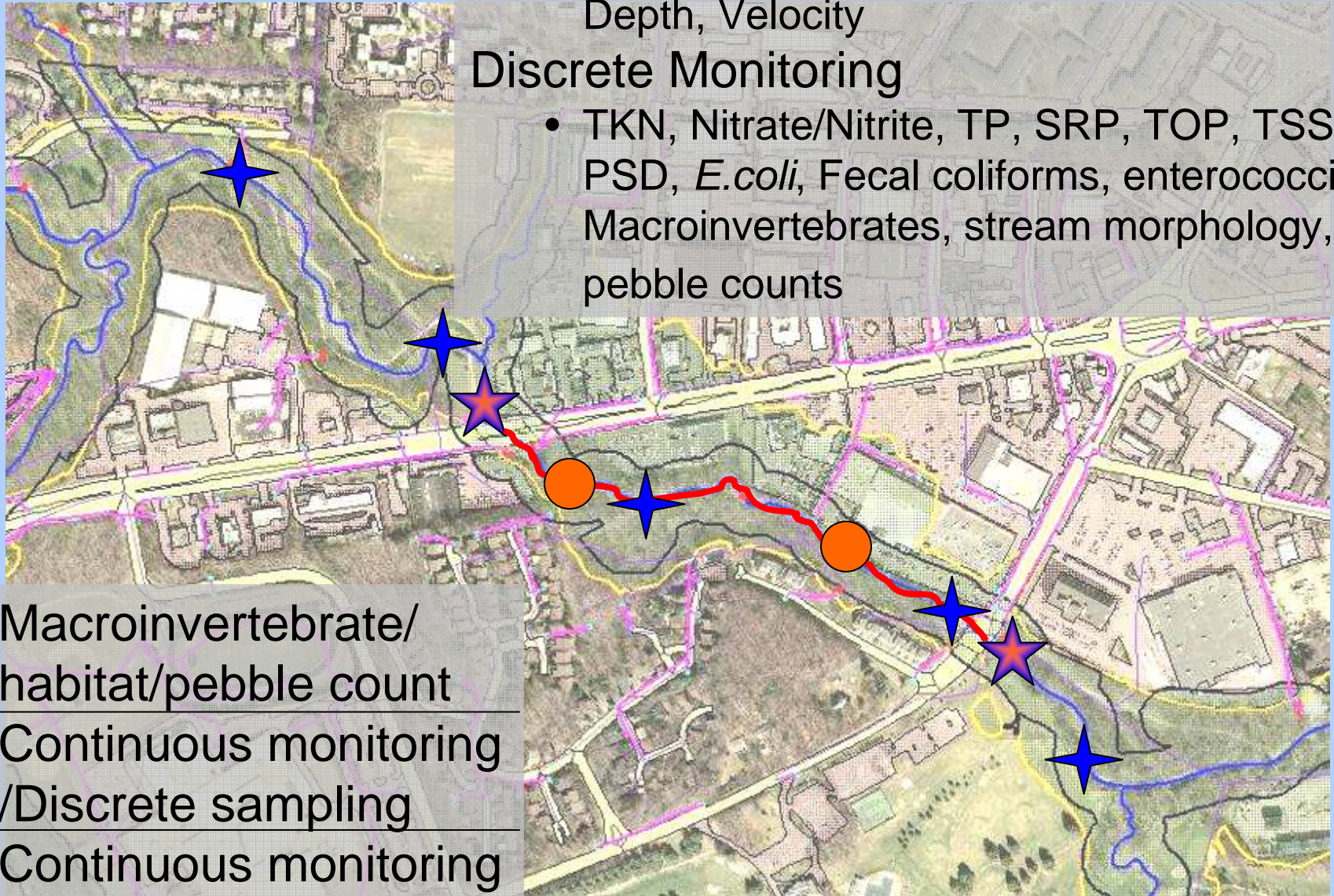
Monitoring

Continuous Monitoring:

- pH, Turbidity, Temp, Conductivity, DO, Depth, Velocity

Discrete Monitoring

- TKN, Nitrate/Nitrite, TP, SRP, TOP, TSS, PSD, *E.coli*, Fecal coliforms, enterococci, Macroinvertebrates, stream morphology, pebble counts



- ★ Macroinvertebrate/habitat/pebble count
- ★ Continuous monitoring /Discrete sampling
- Continuous monitoring



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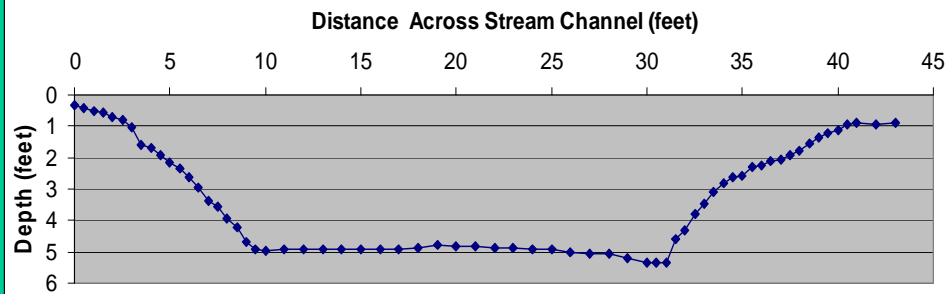
Sampling Results



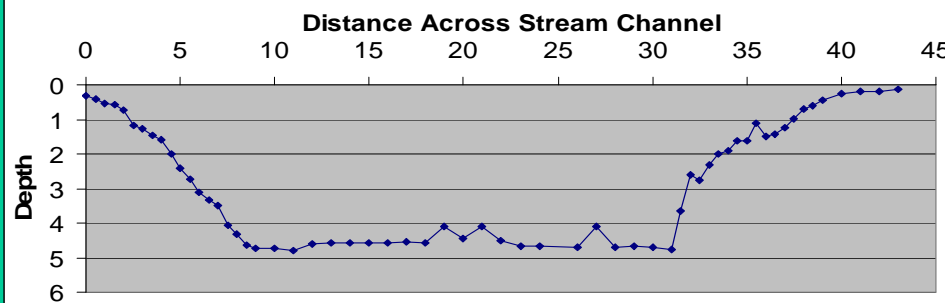
Please note that all US EPA and USGS data are provisional

Cross-Sections

Site A – Upstream of Restoration

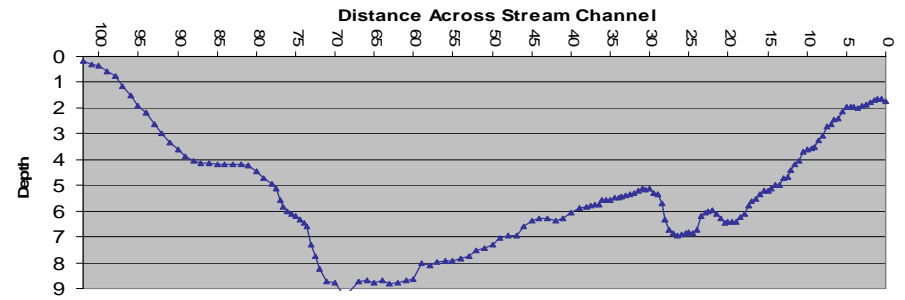


Before Restoration

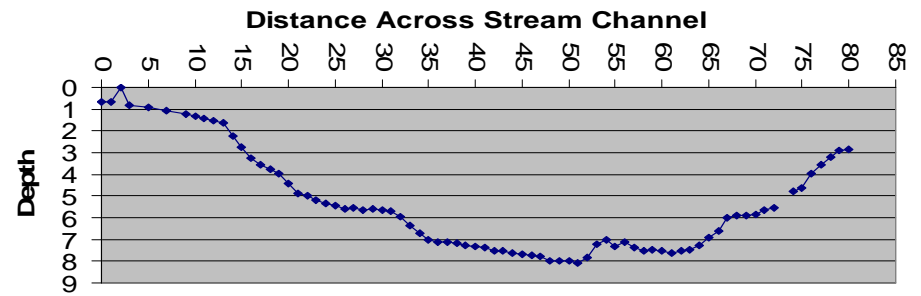


After Restoration

Site C – Lower Part of Restoration



Before Restoration



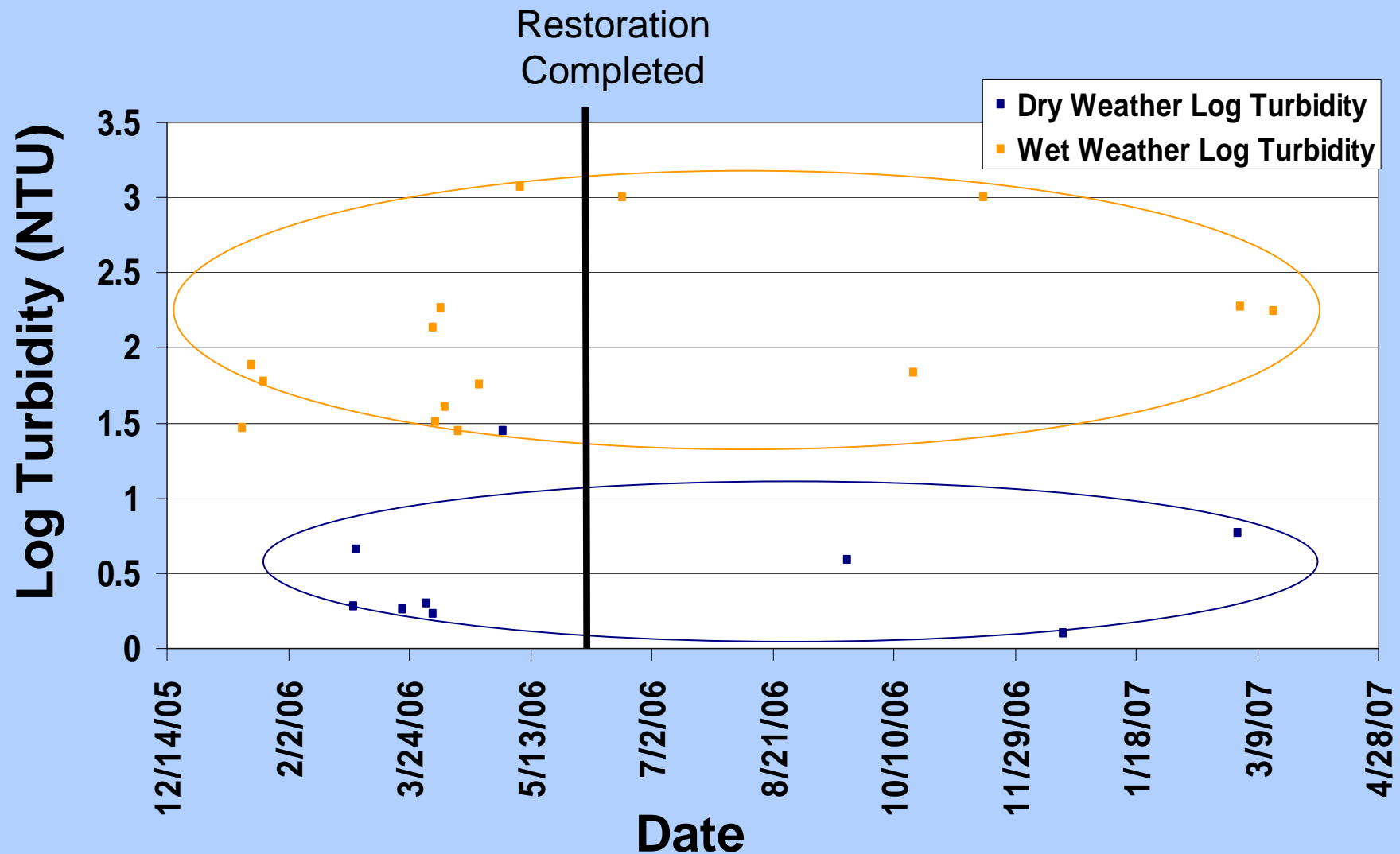
After Restoration



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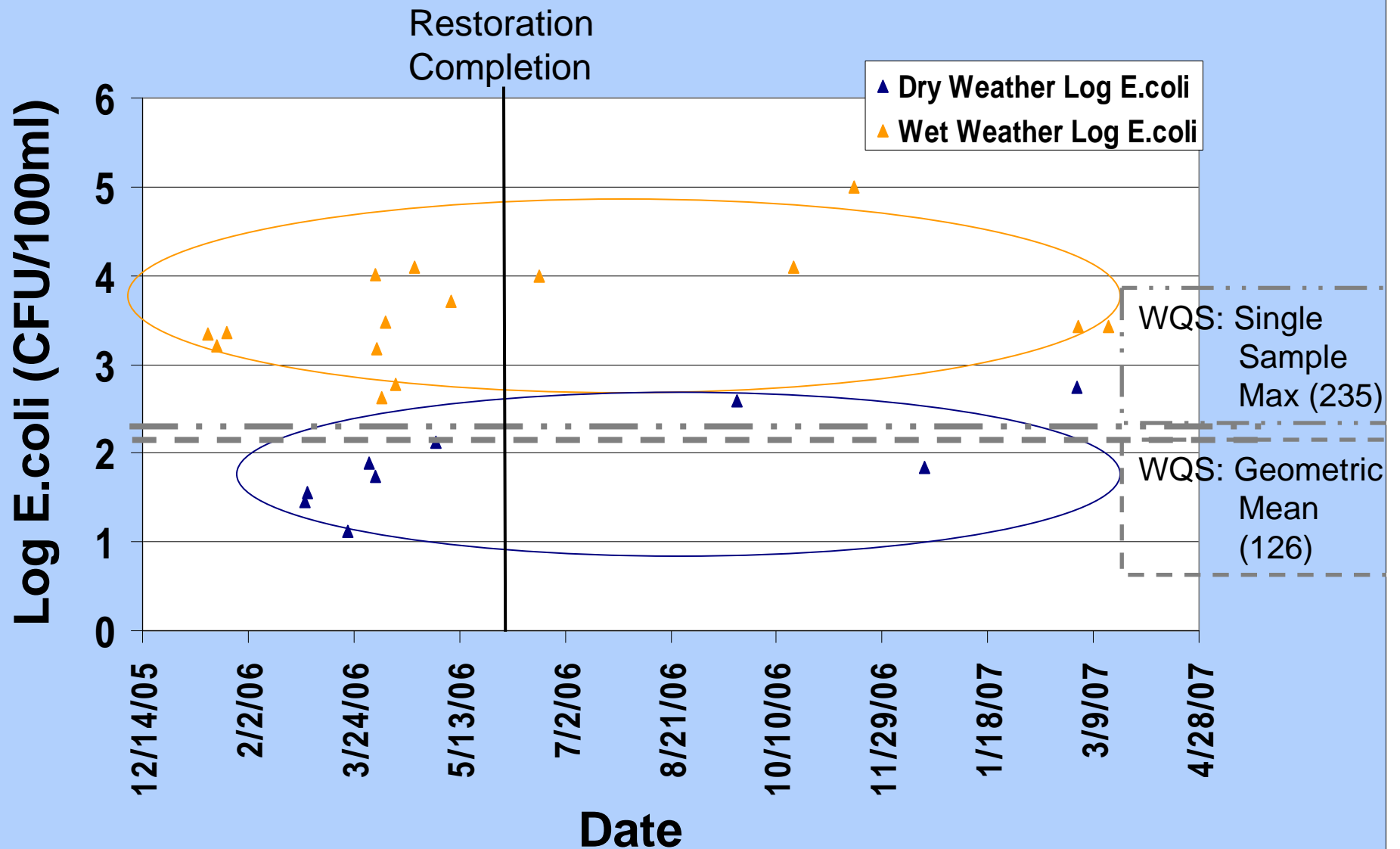
Turbidity Data



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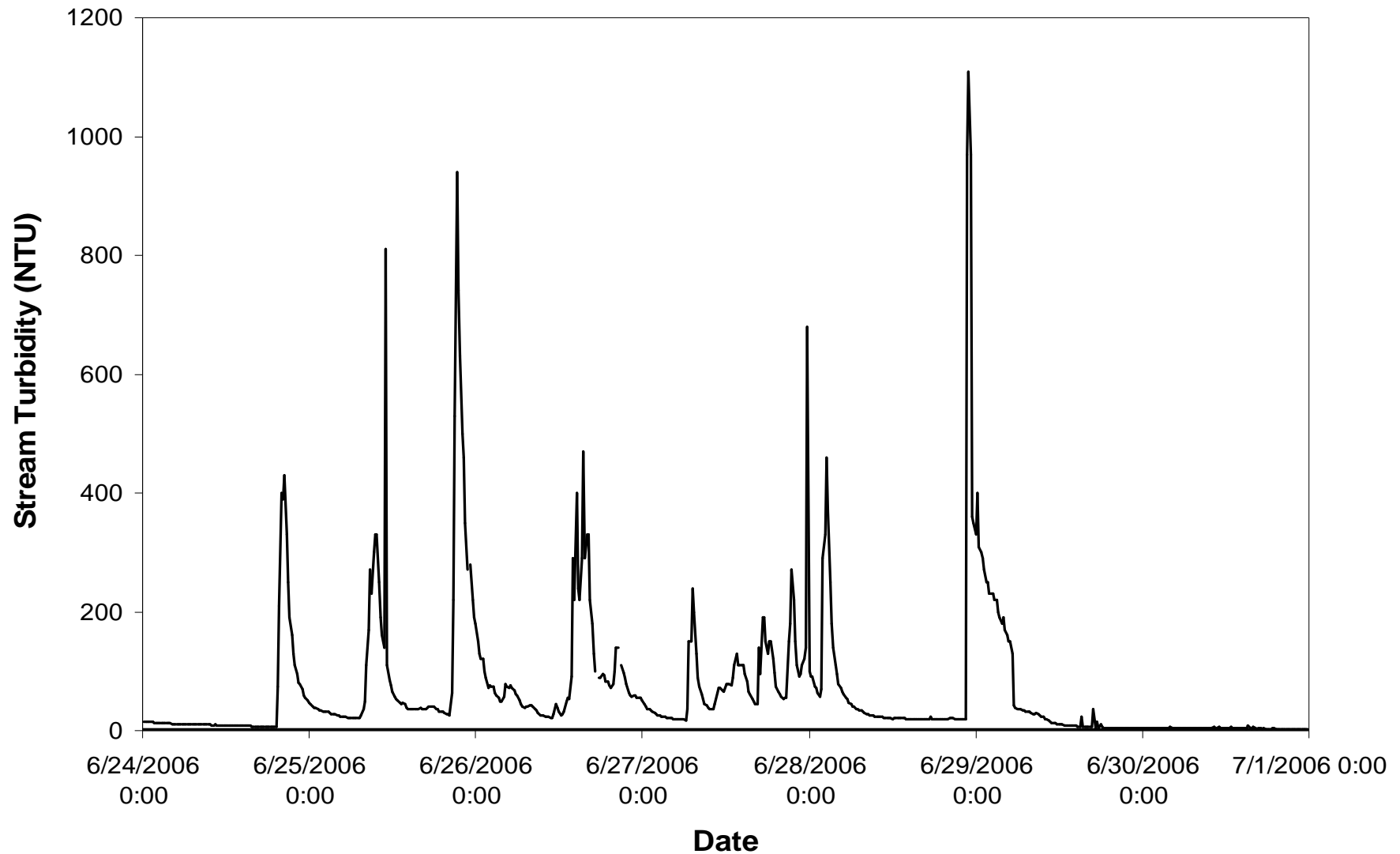
E.coli Concentrations



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Accotink Creek At Old Lee Hwy (June 2006 storms)

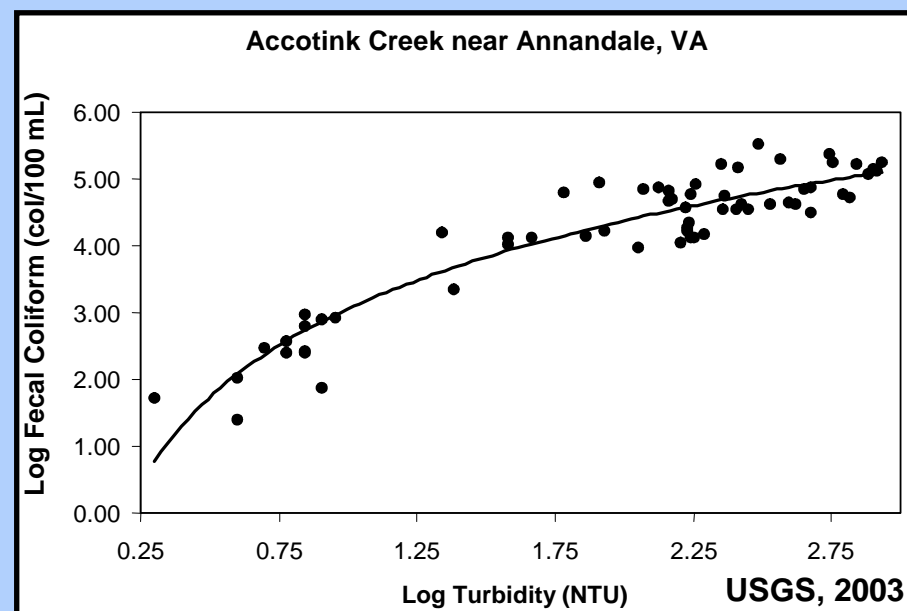
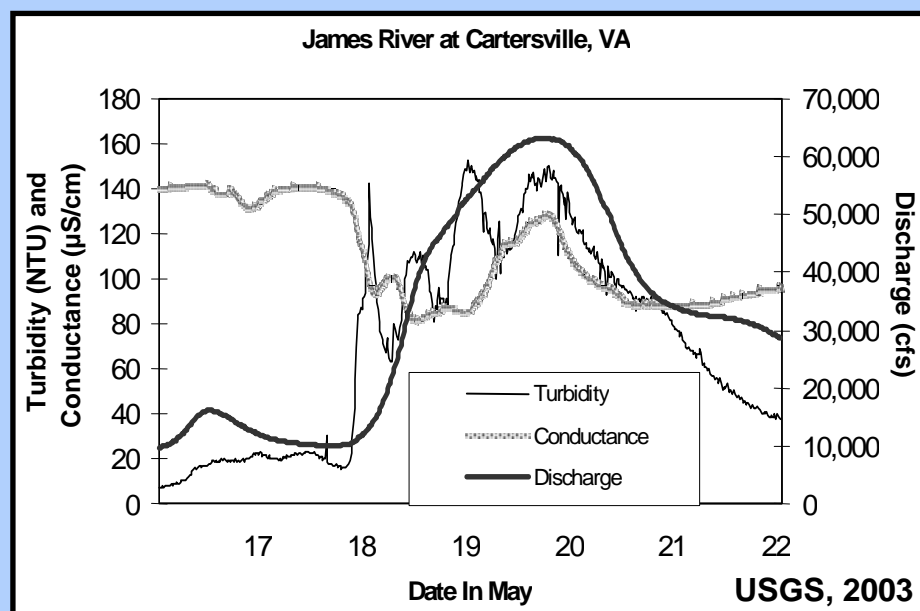


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Combining Discrete and Continuous Data

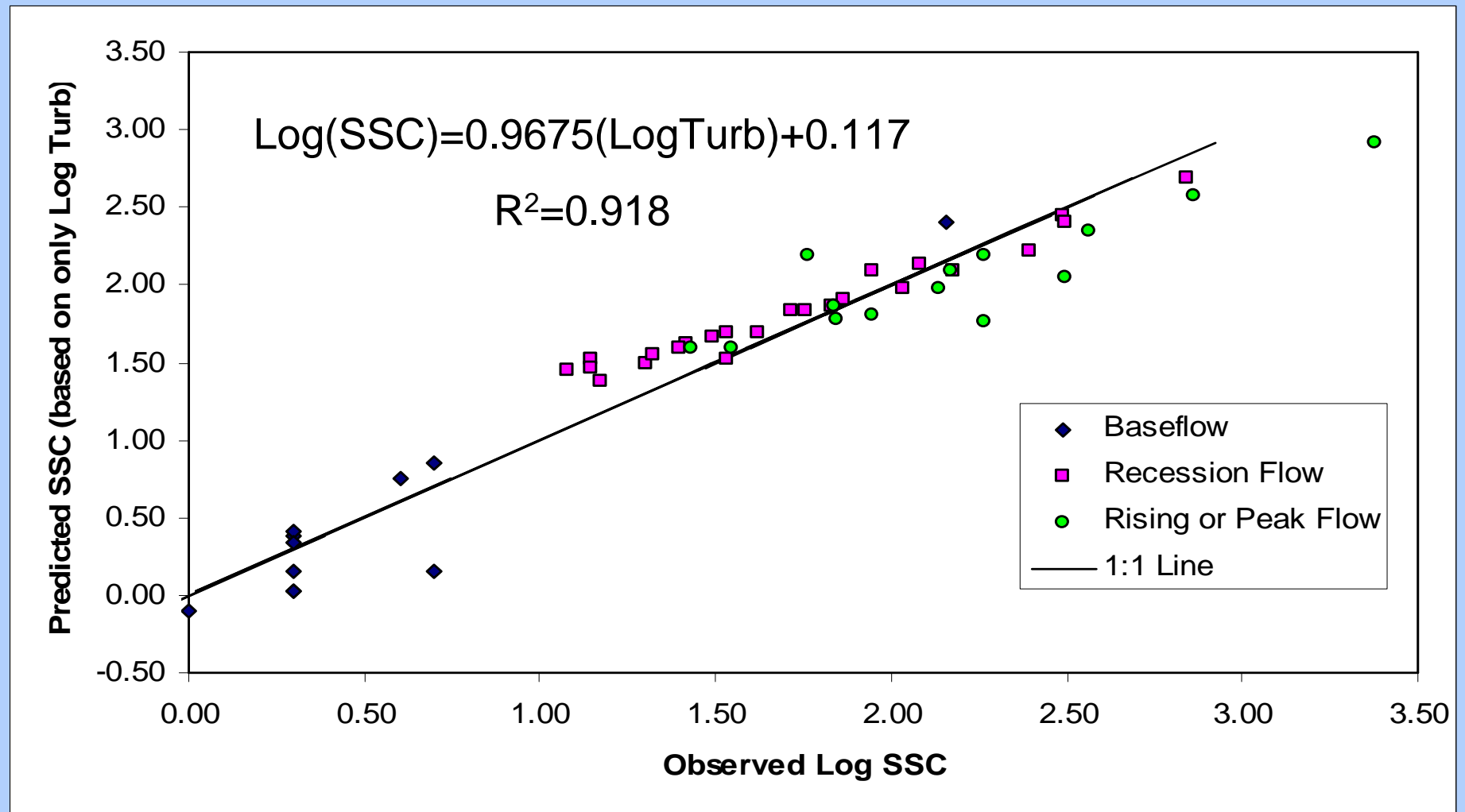
- Use continuous monitoring parameters (i.e. turbidity).
- Regress with discrete WQ parameters (i.e. fecal coliform, suspended sediment)
- Develop concentration estimation curves (similar to water level/flow rating curves)



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Predicting Suspended Sediment Conc (SSC)



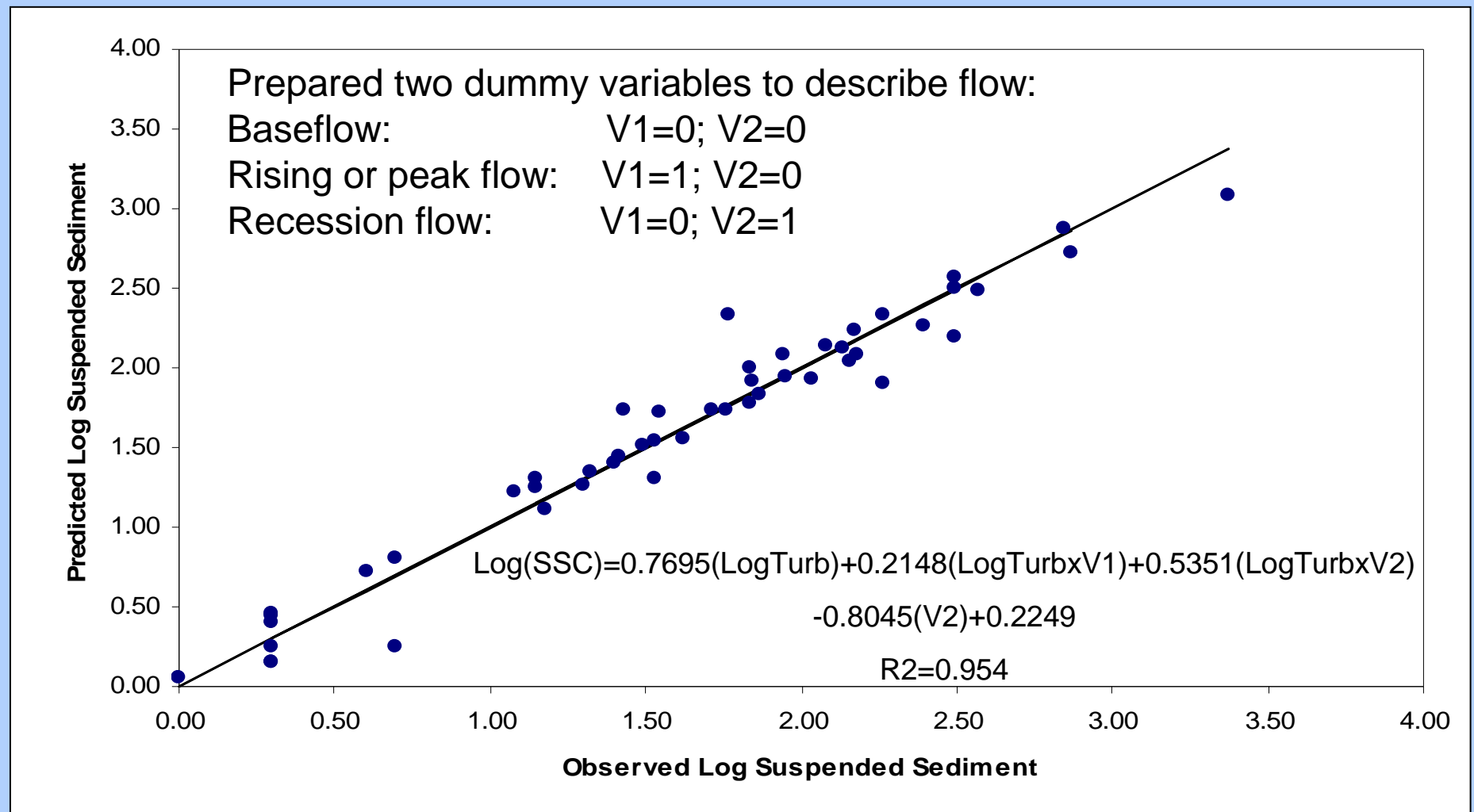
This simple model is reasonable, but there appears to be variability based on hydrological conditions (this is especially evident in the residuals)...



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Predicting Suspended Sediment Conc (SSC)



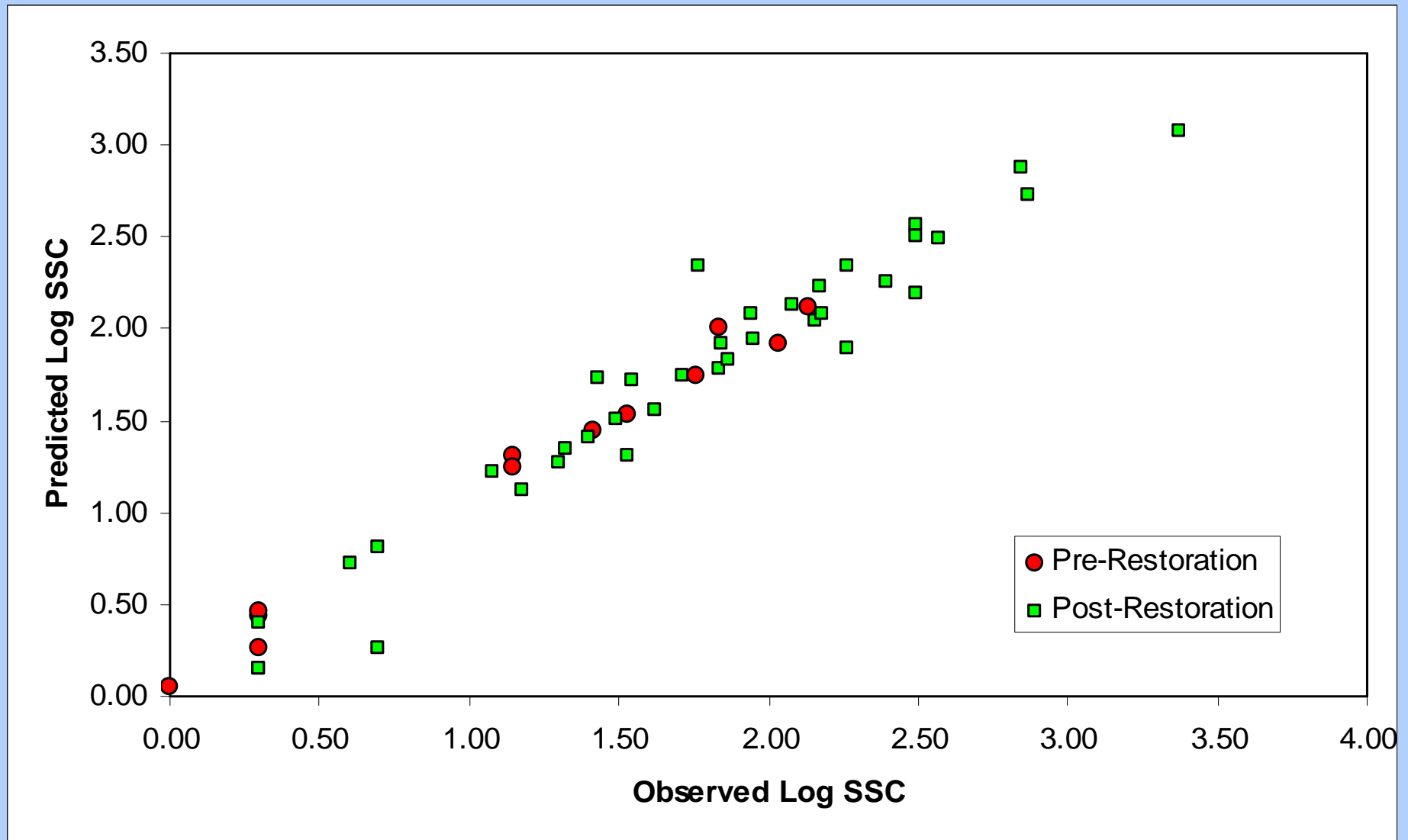
Revised model that includes flow conditions improves the prediction of SSC
(and the residuals look much better)



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Effect of Sample Timing?



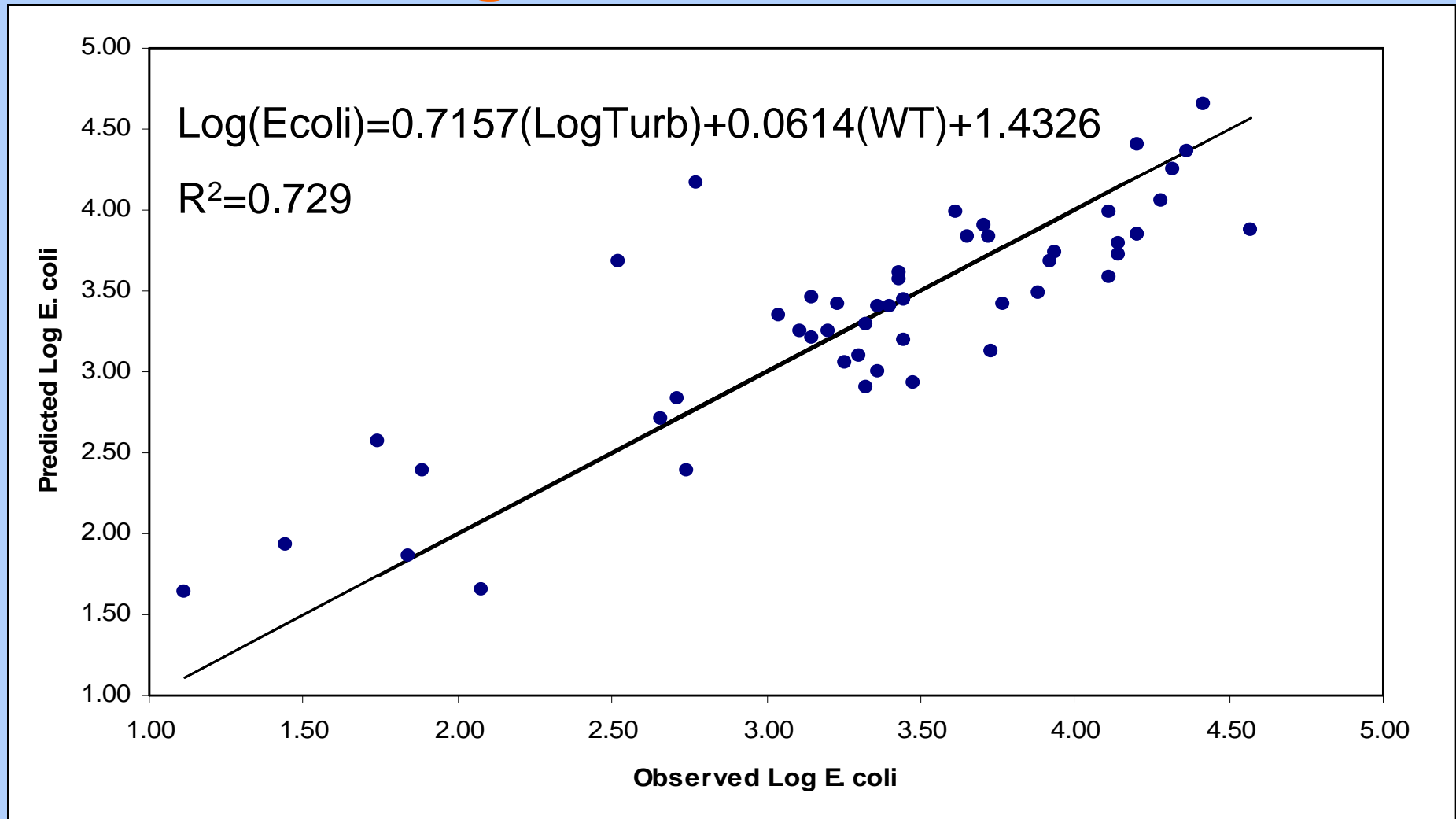
No statistically significant difference between Pre- and Post-Restoration data.



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Predicting E. coli Concentrations



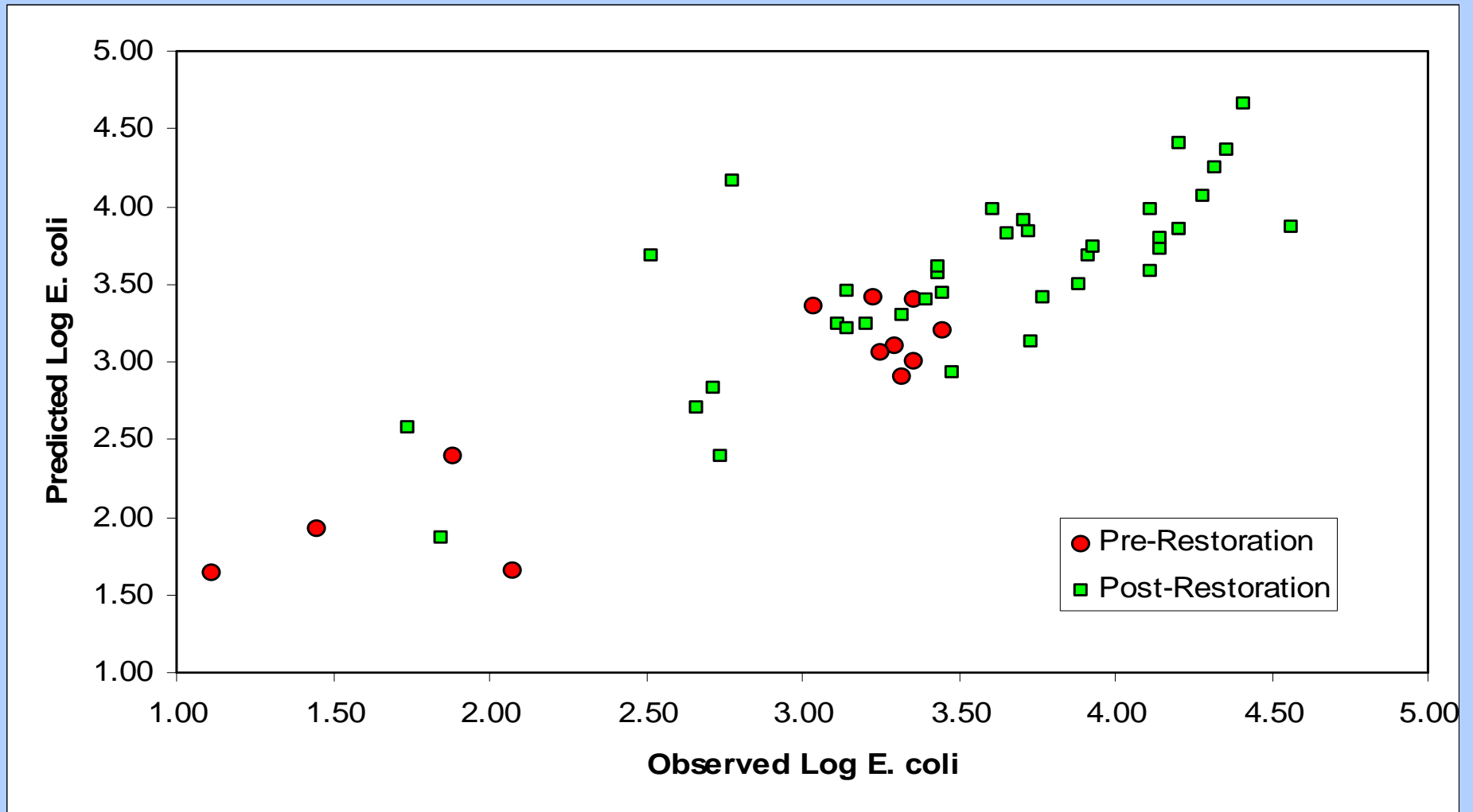
A reasonable predictive model can be developed, but the data are much more variable than the sediment data.



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Effect of Sample Timing?



No statistically significant difference between Pre- and Post-Restoration data.



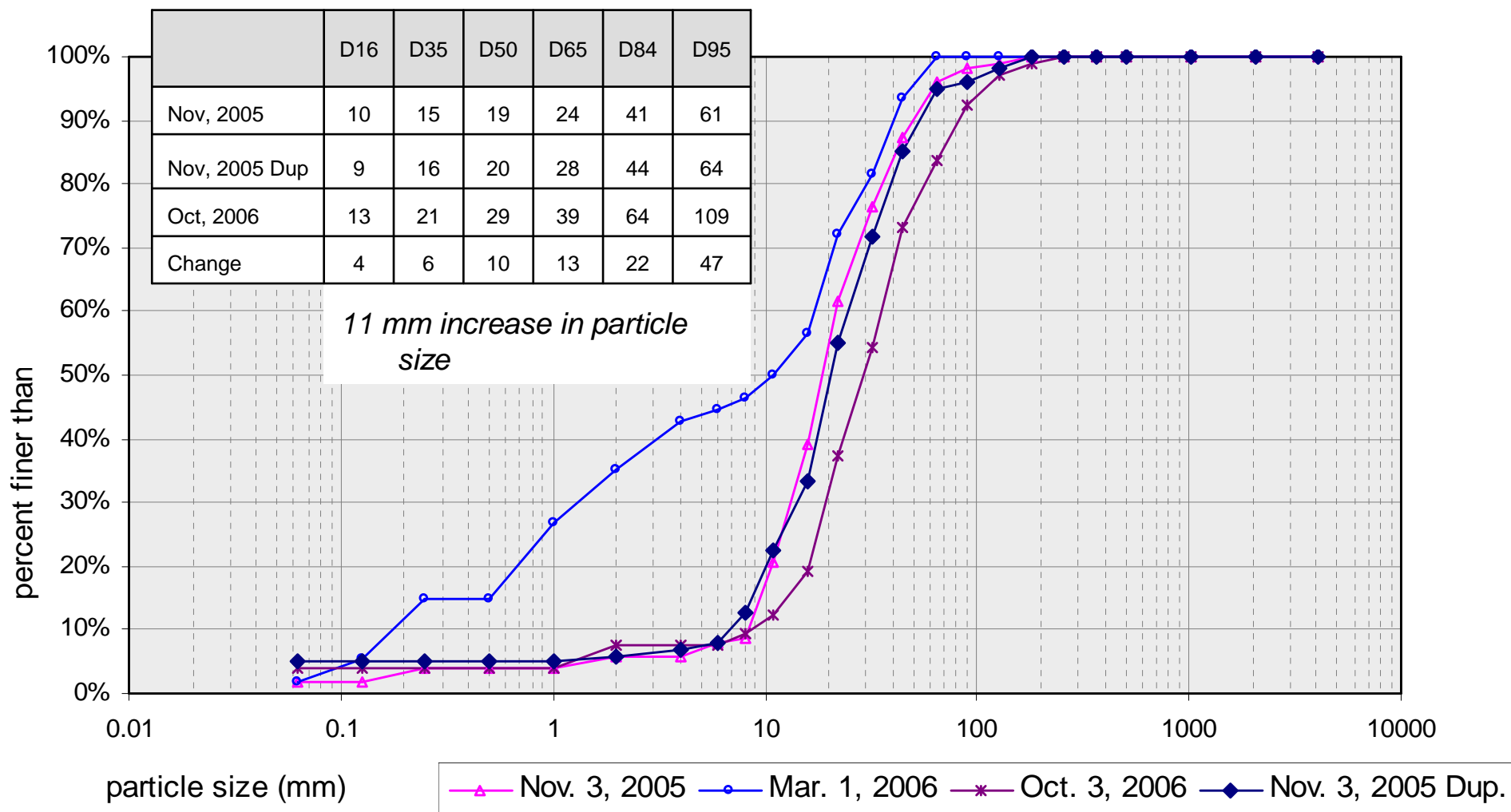
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Pebble Count Data – Changes in streambed substrate?

Site D - Downstream of Old Lee Highway

Below Restoration



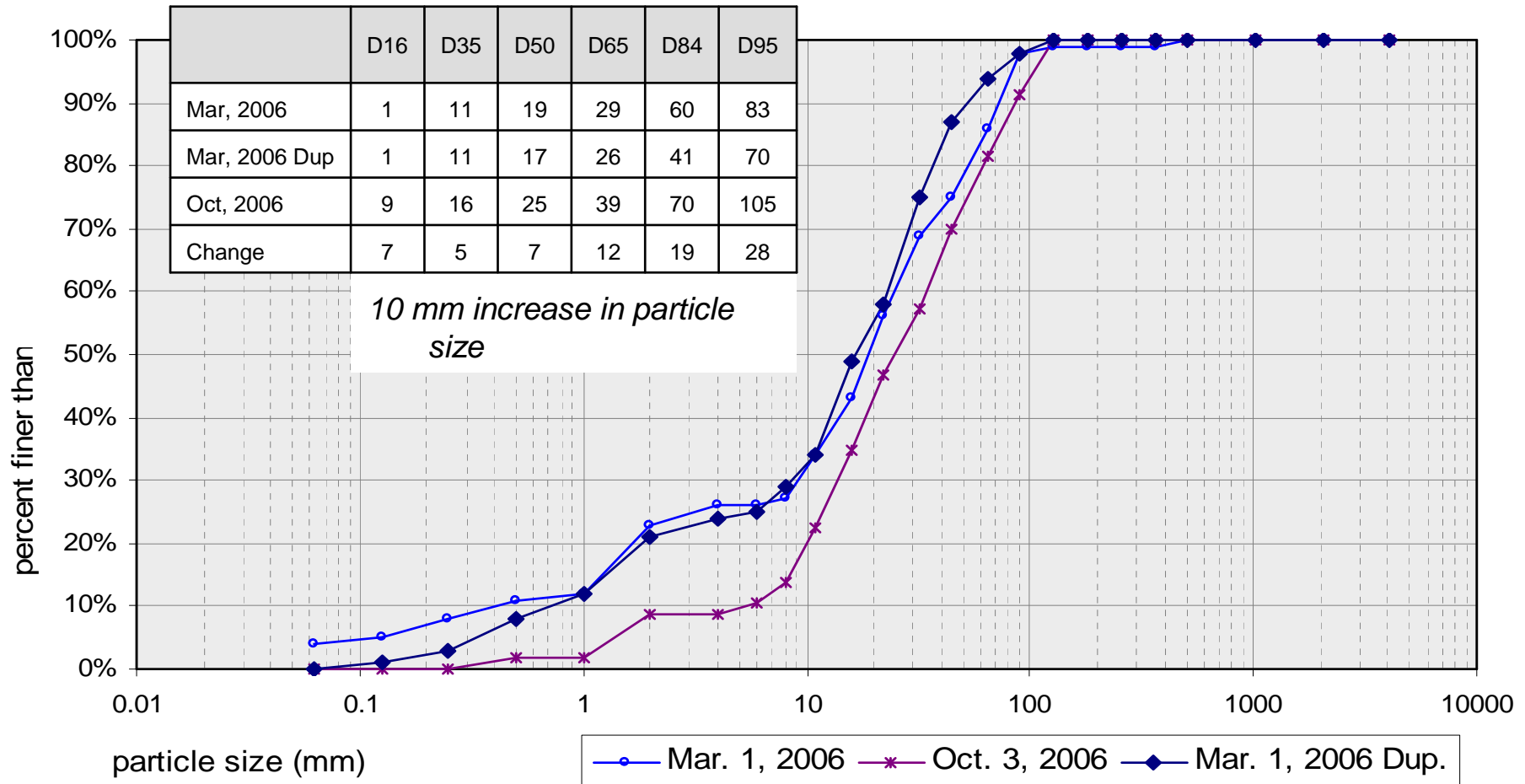
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Pebble Count Data – Changes in streambed substrate?

Site 5 - Ranger Road

Above Restoration



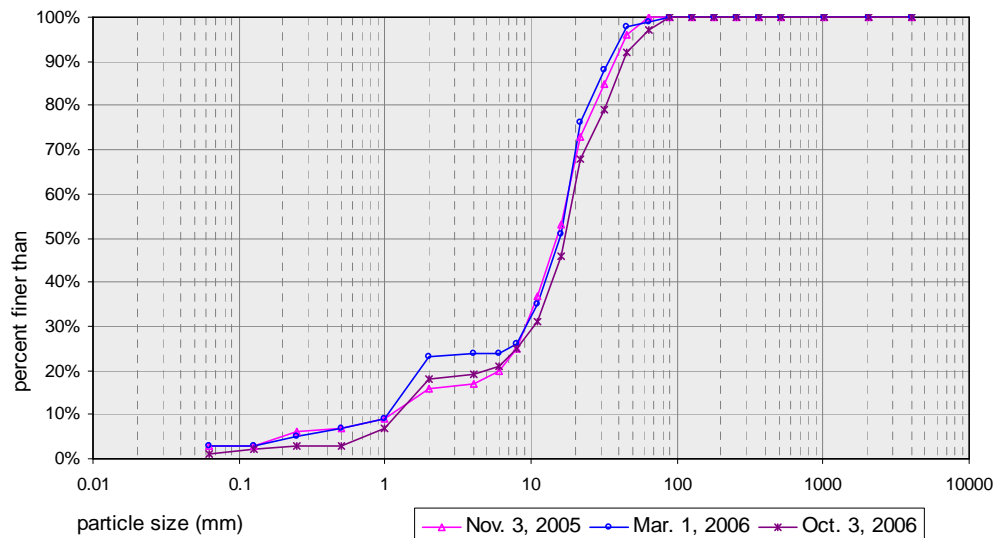
Particle size change may not result from restoration, based on upstream control.



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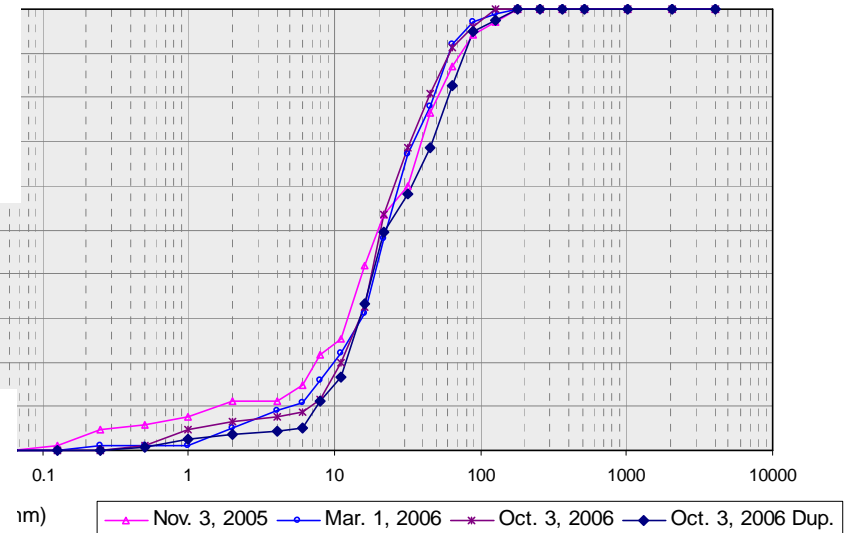
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Site A - Upstream of Lee Highway Bridge

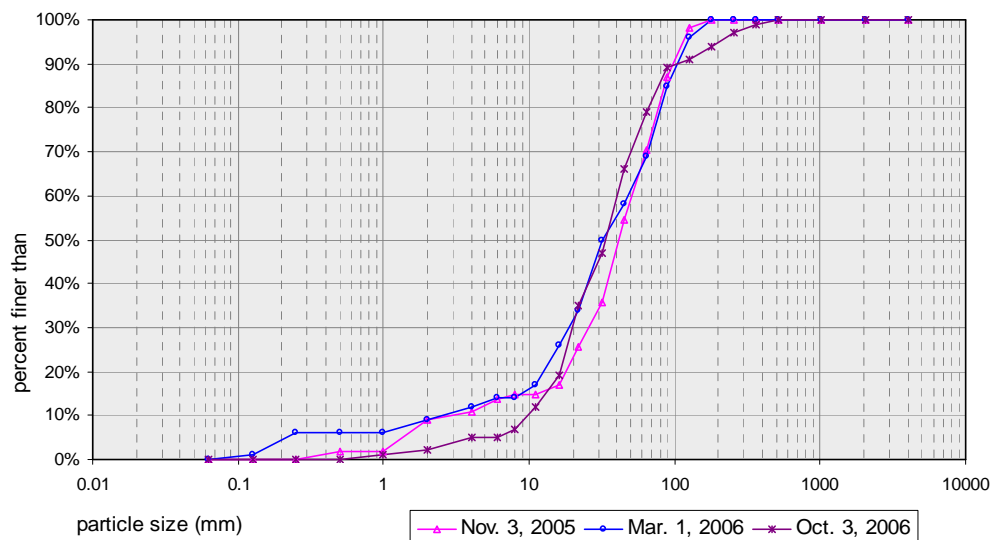


The remaining three sites demonstrate little variability over time

Site B - Below Lee Highway at Harley Dealer

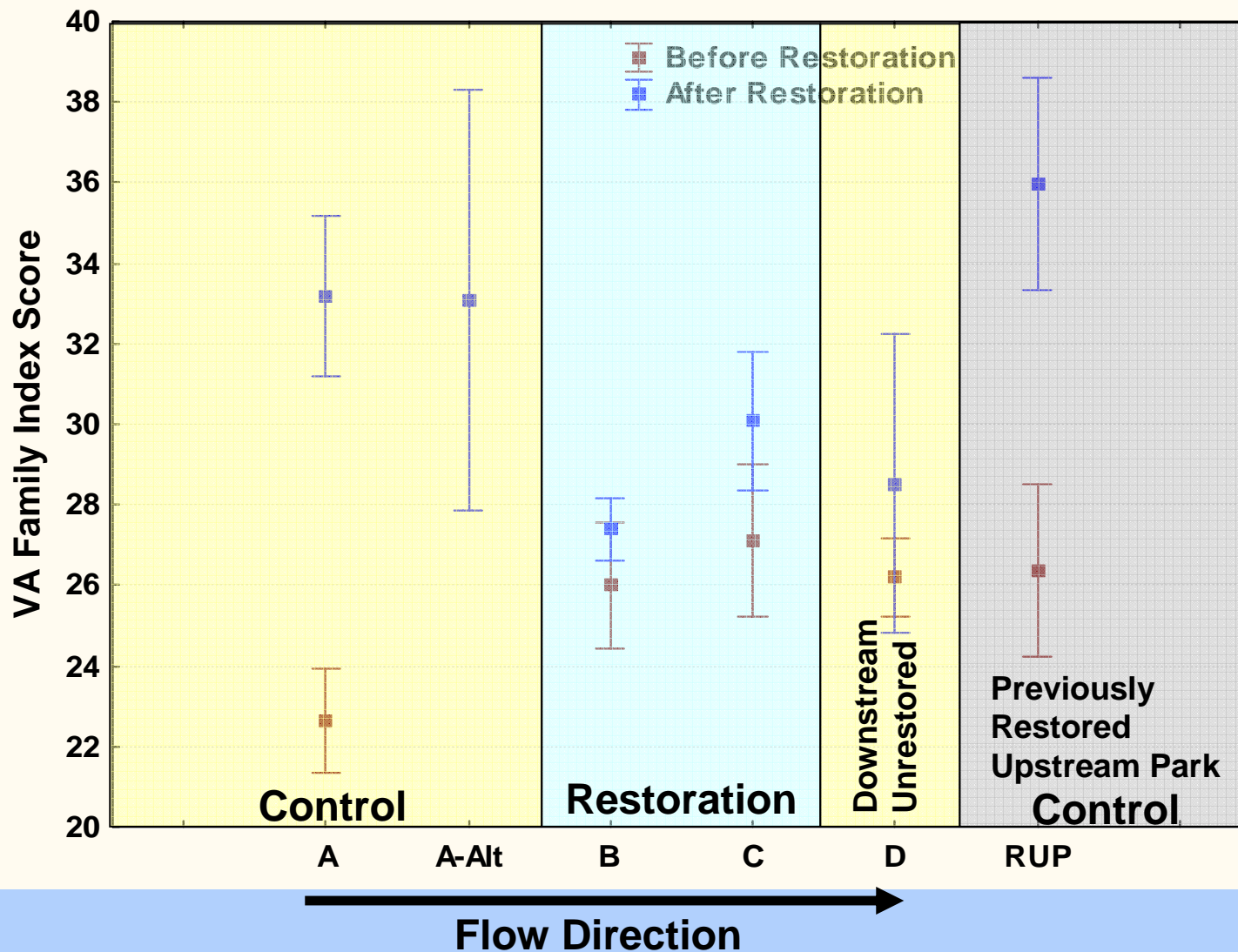


Site C - Upstream of Old Lee Highway



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Macroinvertebrate Indices-Overall



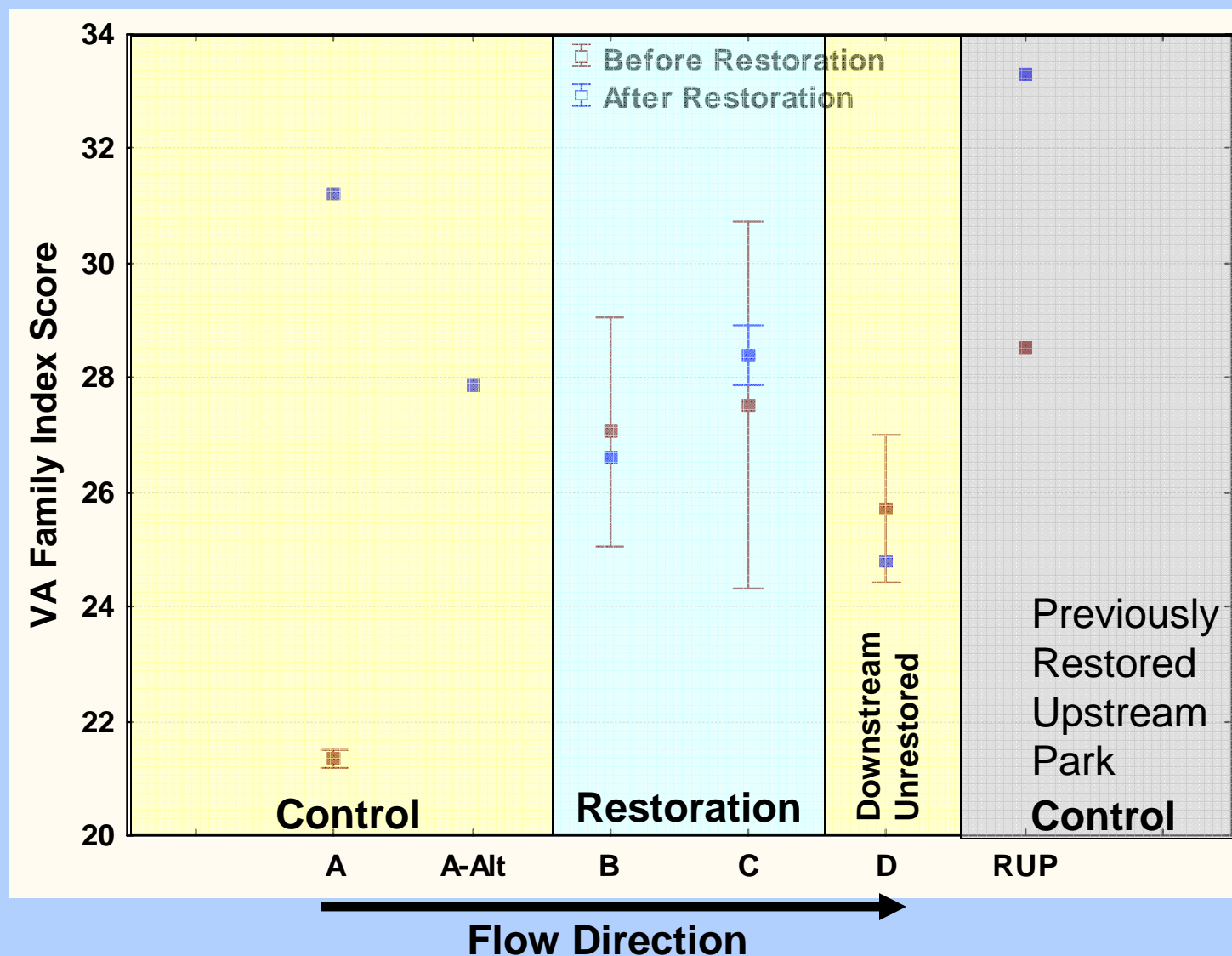
Source: Using Probabilistic Monitoring Data to Validate the Non-Coastal Virginia Stream Condition Index. 2006. VDEQ Technical Bulletin WQA/2006-001



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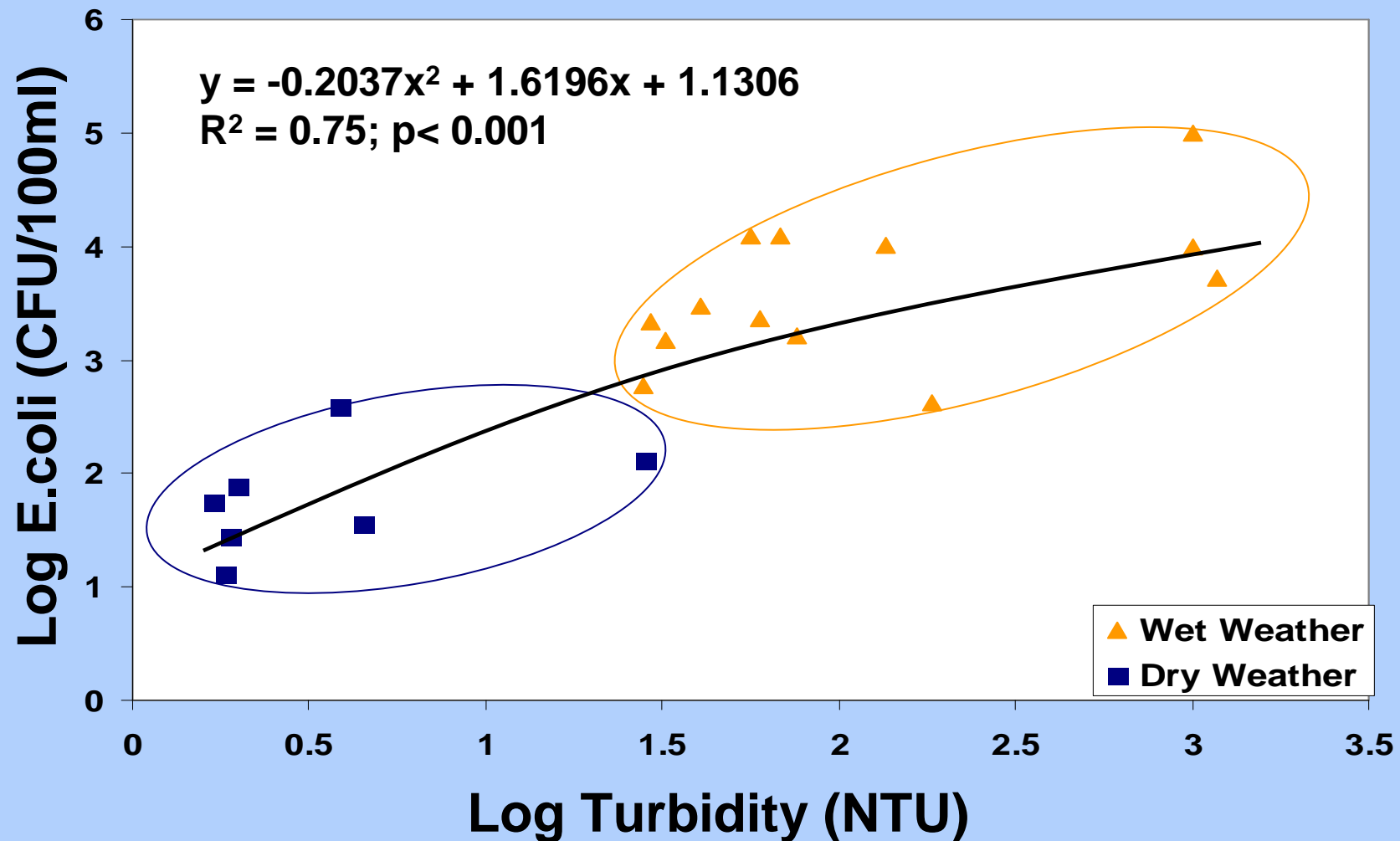
Macroinvertebrate Indices-Fall



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Dry and Wet Weather Contribution?



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What is the source of fecal contamination?



?



?



?

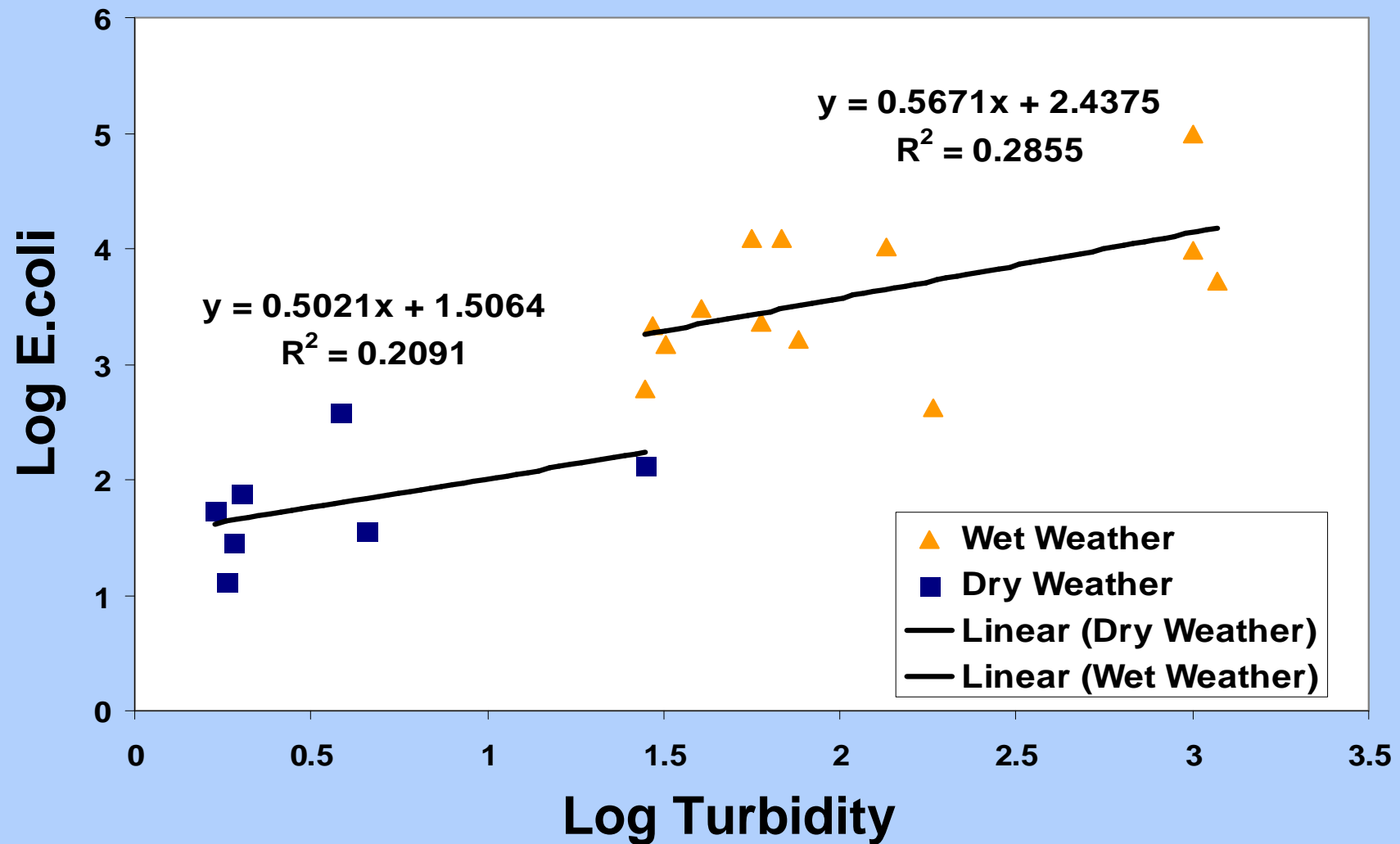
The source affects the predictive relationship!



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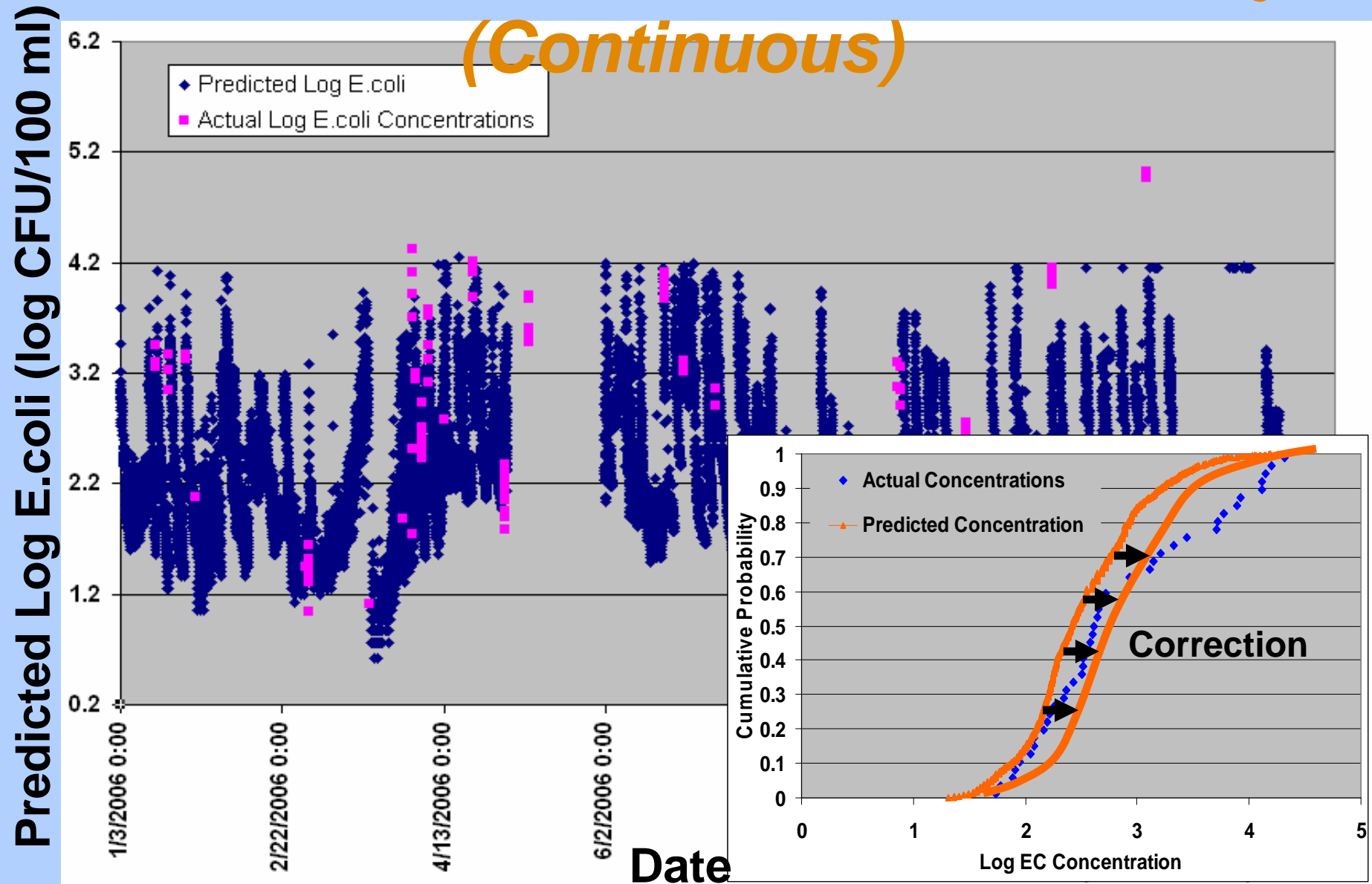
Dry and Wet Weather Contribution?



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Predicted *E. coli* Based on Turbidity (Continuous)



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Future Directions Phase I & II

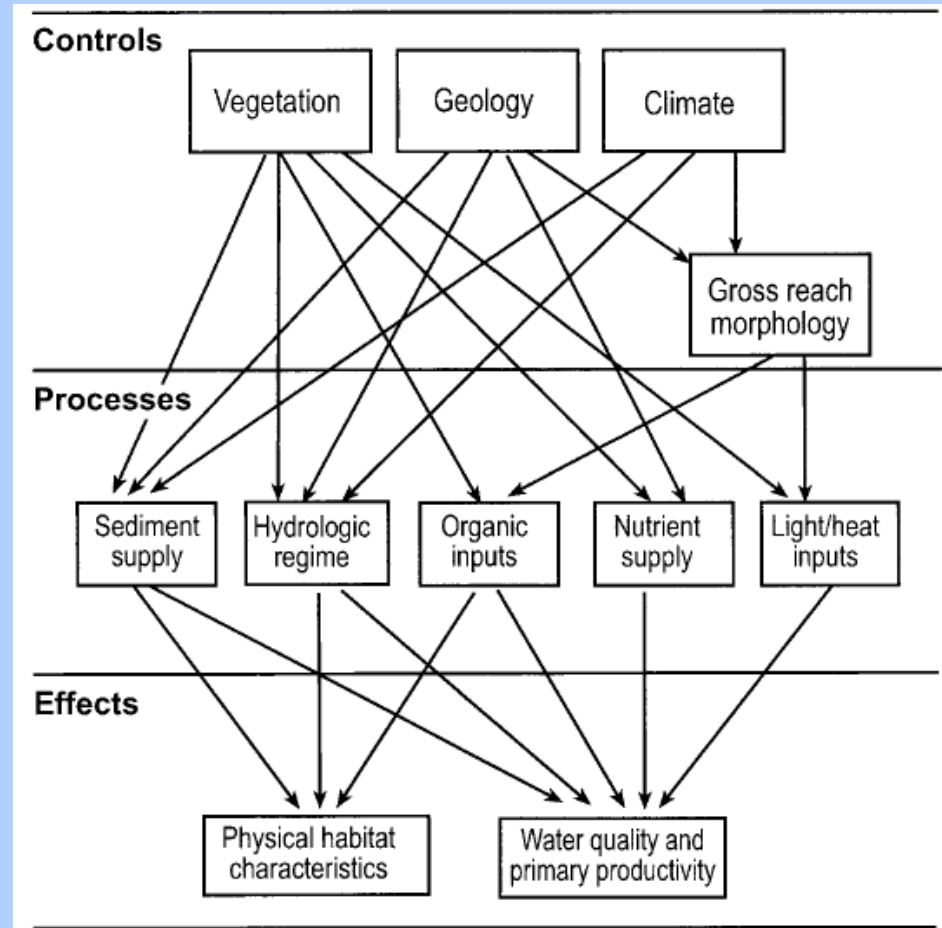
- Continuous monitoring of WQ and flow
- Collect WQ wet and dry weather discrete samples
- Quarterly biological sampling
 - Benthic macroinvertebrate sampling
 - Vegetation
 - RBP habitat assessment
- Annual stream morphology sampling
 - Cross-sectional sampling
 - Longitudinal surveying
- Quarterly stream pebble counts
- Sampling of other implemented watershed improvements (based on priority list)
- Link with economic benefits?



Is the Goal of Restoring Hydrologic Conditions Achievable?

Stream restoration is one tool to protect banks and infrastructure in urban watersheds

Incremental or partial restoration of key controls and processes is necessary (i.e., hydrologic conditions).



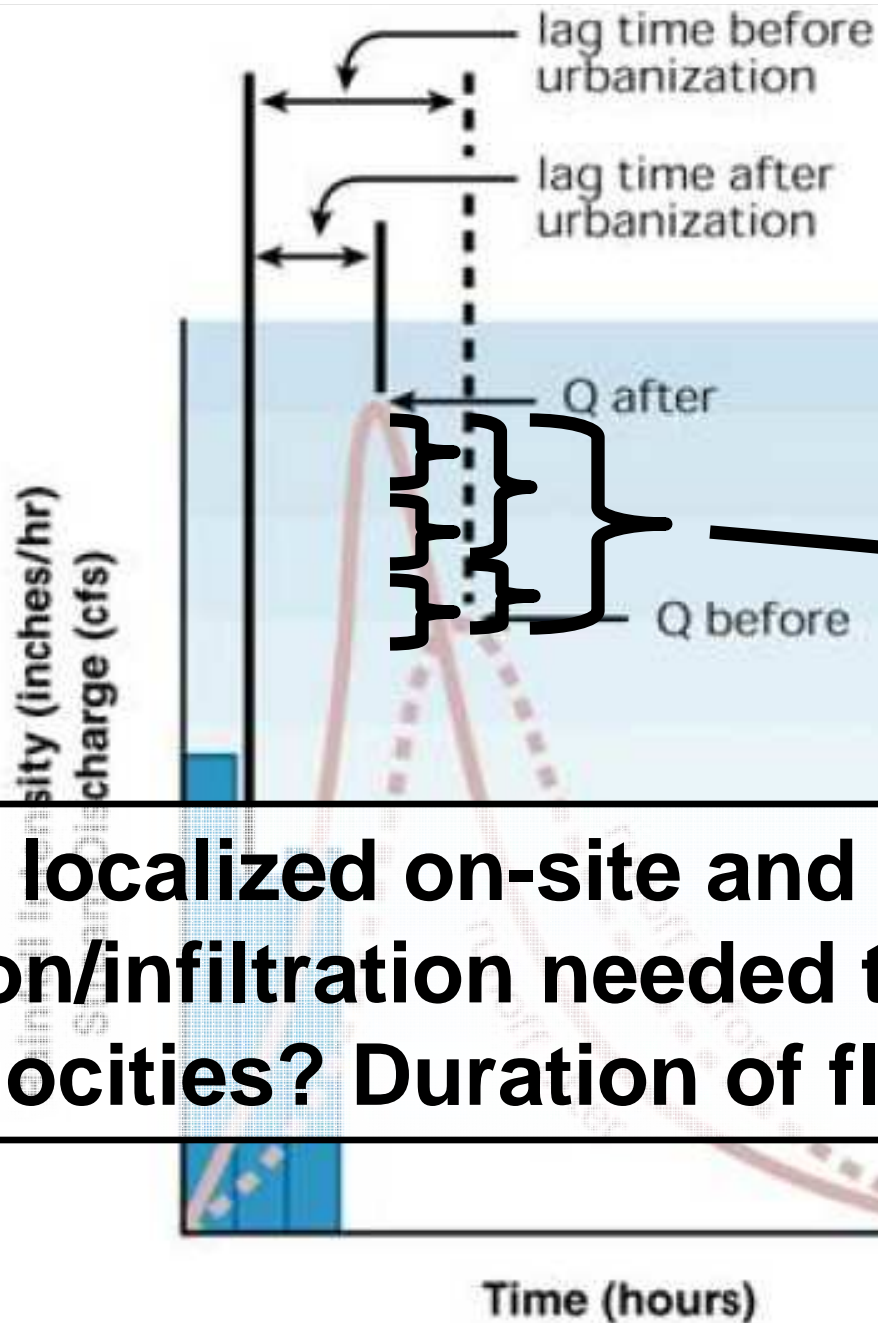
Roni et al., 2002

Other management practices are also needed!



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Longer Term
Results and
Outcomes?

Is more localized on-site and regional detention/infiltration needed to reduce peak flow velocities? Duration of flow velocity?



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Existing BMP Type and Location

Geocoding Results

Retention Structure Type

- Bioretention
- Dry Pond
- Dry Pond w/Bioretention
- Oil/Grit Separator
- Percolation Trench
- Sand Filter
- Stormceptor
- Wet Pond
- Concrete Vault
- Underground Pipes

— Roads

— Streams

■ Watershed



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Potential Retrofits for Upland and Watershed Management

Type of Site	Site Name	Proposed Practice	Drainage Area (ac)	Impervious Area (ac)
Detention pond and other LID controls for impervious area	Fairfax High School	Pond/ wetland and Other	29.36	12.66
	Outfall behind Mazda dealership	Pond/ wetland	62.58	21.87
Dry Pond Conversion	Outback Steakhouse and Kentucky Fried Chicken	Dry pond conversion	2.46	2.02
	Bank of America	Bioretention	0.98	0.72
Bioretention/ Swales	Police Station	Bioretention	0.95	0.29
	Bowl America - Back	Dry swale	2.31	2.24
	Van Dyck Park - Gravel Parking Lot	Bioretention	1.61	0.62
	Draper Park	Rain gardens	3.39	0.84

Team with City and others!!!



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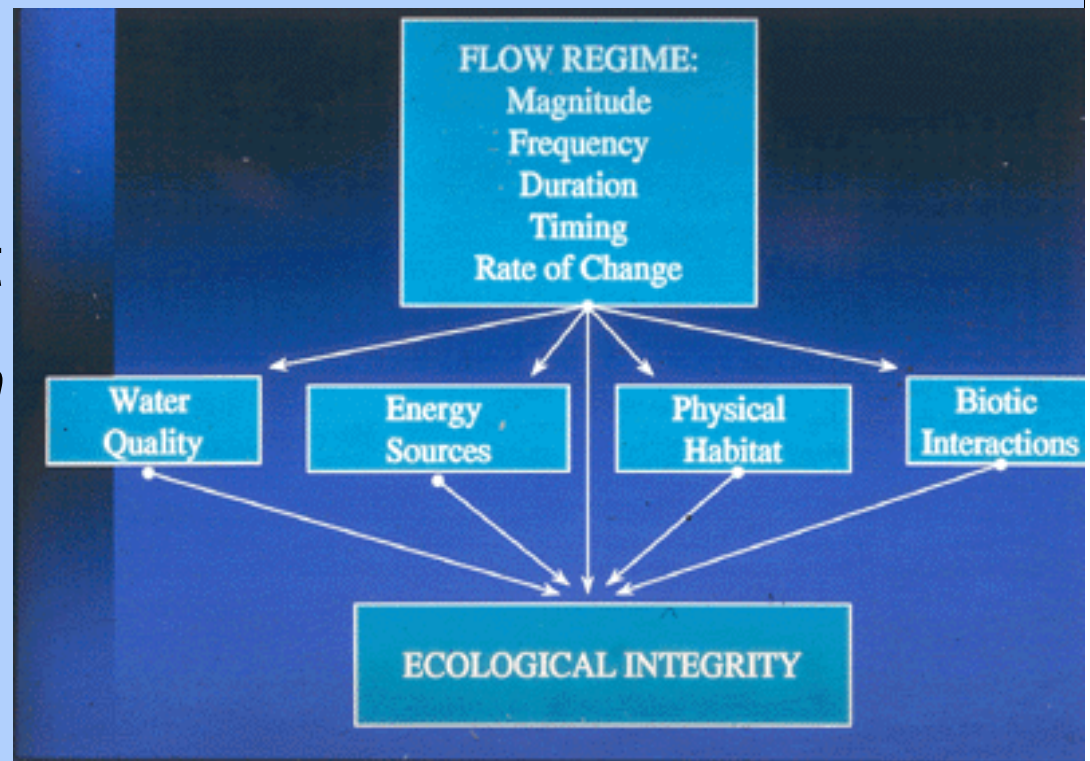
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Conclusion

Provide case study information to MS4's

- Reasonable WQ and habitat improvement tools and expectations for stream restoration (and other longer term watershed management)
- Improved hydrologic conditions and lower sediment loads through watershed management

Will improve in-stream ENERGY and WATER QUALITY with ECOLOGICAL INTEGRITY following



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Acknowledgements

- US EPA-ORD NRMRL/WSWRD/UWMB
- US EPA EPA Region III
- US EPA EPA Region III – Laboratory, Wheeling, WV
- US EPA Environmental Technical Council's Urban Runoff Action Team - Pilot Project
- City of Fairfax, Virginia
- Center for Watershed Protection
- George Mason University
- Virginia Department of Environmental Quality
- Northern Virginia Regional Commission
- PARS Environmental
- Friends of Accotink Creek (nonprofit)

Partners to add

- Fairfax County, Virginia
- Others?





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Protecting Urban Streams from Storm Water Runoff Damage

Creeks and streams that are secured by storm water runoff in remote areas of the western U.S. may develop into wild and beautiful landscapes. But when storm waters degrade streams in densely populated urban areas, the results are likely to be deteriorated neighborhood esthetics and polluted recreational areas.

[Storm Water Runoff Damage](#)
Protecting Urban Streams



EPA
Environmental Technology
Verification (ETV)



EVENTS

The Air and Waste Management Association (AWMA) 99th Annual Conference and Exhibition June 20-23, 2006 New Orleans, LA
([Exit Disclaimer](#))

Workshop on Arsenic Removal Demonstration Program: Results and Lessons Learned August 22-24, 2006 Cincinnati, Ohio

Trans-Atlantic Research & Development



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Research Highlights

Protecting Urban Streams From Storm Water Runoff Damage

Creeks and streams that are secured by storm water runoff in remote areas of the western U.S. may develop into wild and beautiful landscapes. But when storm waters degrade streams in densely populated urban areas, the results are likely to be deteriorated neighborhood esthetics and polluted recreational areas. As more and more open and green ways to residential use, the management of storm water runoff becomes crucial for the protection of human and environmental health. EPA water quality specialists are working with municipal storm sewer managers in Fairfax, Virginia, to evaluate a local program to restore streambeds damaged by storm water flow. The project involves a section of a degraded stream channel in Accotink Creek within the city of Fairfax. The research goal is to determine which technologies are most effective in restoring streambeds—before, during, and after the restoration efforts.

Accotink Creek and its tributaries are important natural sources that provide recreational and aesthetic enhancements to the quality of life in Fairfax, Virginia. The headwaters of the creek originate within the city of Fairfax and flow southeast into the Potomac River and, thence, into Chesapeake Bay. Uncontrolled urban runoff from the Accotink Creek watershed has resulted in channel deepening, bank erosion, and sediment transport downstream. Runoff has also adversely affected aquatic life within the creek. Many of the fish and other aquatic populations, important for the creek's viability, have declined.

Since the spring of 2002, the city of Fairfax has been installing stream improvements to upgrade biological and in-stream water quality along sections of the North Fork of Accotink Creek. To evaluate the performance of selected technologies in this effort, operators of the Fairfax Municipal Separate Storm Sewer System called on EPA water quality researchers. The purpose of this cooperative program is to collect and monitor before-and-after data on water conditions in a 1,300-foot section of degraded stream channel of the Accotink Creek.



Questions?

www.epa.gov/ORD/NRMRL/news/news072006.html



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